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THESIS

CONCEPT OF A DYNAMIC ORGANIZATIONAL SCHEMA FOR A NETWORK-CENTRIC ORGANIZATION

by

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June 2003

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Organizational structure has profound effects on a joint force commander's ability to perform military actions. Organizations and their environment exhibit an interdependent relationship, requiring a commander to evolve his organization to rapidly achieve mission accomplishment. The CNO Strategic Studies Group XIX report of September 2000 has identified the FORCEnet as being the basis for the U.S. Navy's future network-centric organization, and outlines a military environment that includes multitudes of manned and unmanned vehicles, platforms, sensors, weapons and warfighters. These naval elements will operate jointly, leveraging organizational structure to rapidly sense, assess, and respond to the defense of the nation's security interests as directed by the President. The focus of this research is to examine this envisioned future military environment, the military actions required to achieve success in that environment and the organizational structure(s) that will best fit those action requirements.

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CONCEPT OF A DYNAMIC ORGANIZATIONAL SCHEMA FOR A NETWORK-CENTRIC ORGANIZATION

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ABSTRACT

Organizational structure has profound effects on a joint force commander's ability to perform military actions. Organizations and their environment exhibit an interdependent relationship, requiring a commander to evolve his organization to rapidly achieve mission accomplishment. The CNO Strategic Studies Group XIX report of September 2000 has identified the FORCEnet as being the basis for the U.S. Navy's future network-centric organization, and outlines a military environment that includes multitudes of manned and unmanned vehicles, platforms, sensors, weapons and warfighters. These naval elements will operate jointly, leveraging organizational structure to rapidly sense, assess, and respond to the defense of the nation's security interests as directed by the President. The focus of this research is to examine this envisioned future military environment, the military actions required to achieve success in that environment and the organizational structure(s) that will best fit those action requirements.

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LIST OF ACRONYMS

AOR	Area of Responsibility
CCRP	C4ISR Cooperative Research Program
CJCS	Chairman of the Joint Chiefs of Staff
CNO	Chief of Naval Operation's
COCOM	Combatant Commander
C2	Command and Control
CAS	Complex Adaptive System
CONPLAN	Conceptual Plan
COA	Course of Action
EBO	Effects Based Operations
FUNCPLAN	Functional Plan
JFCOM	Joint Forces Command
JIACG	Joint Interagency Coordination Group
JOPES	Joint Operation Planning and Execution System
JSCP	Joint Services Capabilities Plan
JTF	Joint Task Force
NMS	National Military Strategy
NSS	National Security Strategy
NCW	Network-Centric Warfare
NESCI	New England Complexity Science Institute
NEO	Non-combatant Evacuation Operation
OEF	Operation ENDURING FREEDOM
OIF	Operation IRAQI FREEDOM
ONA	Operational Net Assessment
OPLAN	Operational Plan
POTUS	President of the United States
QDR	Quadrennial Defense Review
R&D	Research and Development
SAR	Search and Rescue

SecDef	Secretary of Defense
SA	Situational Awareness
SJFHQ	Standing Joint Force Headquarters
SSG	Strategic Studies Group
USW	Undersea Warfare
UCMJ	Uniform Code of Military Justice
US	United States
UAV	Unmanned Aerial Vehicle
UCAV	Unmanned Combat Air Vehicle
USN	United States Navy

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I. INTRODUCTION

A. OVERVIEW

Terrorist networks are emerging as the principal threat to the United States (US) security in the 21st Century. These networks are both physical and social, and are comprised of many non-state actors widely dispersed around the globe.[1] In some cases, they have very specific objectives. In others however, their objectives are not as clearly defined, and their target set is even less so. These networks challenge traditional military platform-centric, or hierarchical, organization as the terrorist network chooses the battlefield. A hierarchical organization is not well suited to such a security environment, where the source of conflict is vetted globally as opposed to a singular geographic location. The platform-centric organization is an Industrial Age holdover, and minimizes advantages to be obtained through networking, dispersal of forces, and distribution of combat power. In the author's opinion, the U.S. military must reorganize as a network-centric force, fully netted to service, coalition, national and commercial information sources that may be leveraged to protect national security interests.[2]

Network-centric as it applies to a military organization is a term that developed from the concept of Network-Centric Warfare (NCW). This concept is outlined by Alberts, Gartska, and Stein in their book Network-Centric Warfare, published as a continuation in the series of publications by the C4ISR Cooperative Research Program (CCRP). They define NCW as:

> An information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization. In essence, NCW translates information

[1] A physical network refers to a network united through physical connections such as a computer network. A social network is referred to here as a network of similar minded individuals that conform to a common cause.

[2] As defined in the U.S. National Security Strategy, 30 September 2001.

> superiority into combat power by effectively linking knowledgeable entities in the battlespace (Alberts, Gartska, and Stein, 1998).

Their model for NCW is designed around the Network-Centric Enterprise, which itself has a network infostructure as the underlying basis. This infostructure refers to a physical network, but the value, or effectiveness, created by the network is the true enabler to creating competitive advantage. The physical network, while required for network-centric operations, does not in and of itself guarantee that the value of the organization is increased. Rather it is the application of the created knowledge that has emerged as the "principle component of competitive advantage" (Alberts, Gartska, and Stein, 1998). The creation of the physical infostructure is an underlying assumption in this thesis, as is the value that is created as a result. The emphasis instead is on the ability of a joint force to operate as a network-centric organization.[3]

Alberts, Gartska, and Stein identify several key concepts as they apply to Network-Centric Warfare, and that are also used in this thesis as assumptions that they exist in the proposed network-centric organization. The first concept is that the joint force utilizes geographically dispersed forces to conduct warfare. Second, these forces are assumed to be knowledgeable, utilizing the network to increase their situational awareness and share a common understanding of the commander's intent, doctrine and training required to operate cohesively. Finally, the network is effective in linking these elements together resulting in a capacity for work that can be "dynamically reallocated to adapt to the situation" (Alberts, Gartska, and Stein, 1998). This latter point will be used throughout the thesis to identify a requirement of the network-centric organization to rapidly reconfigure to match changes in environmental contingencies.

B. THE COMPLEX ENVIRONMENT

The inter relationships of globalized partnerships, actions and effects define a highly complex environment. This environment is asymmetric, that is it matches

[3] Joint Force is used here to identify a generic joint force as it is defined in Joint Publication 3-0. Specific reference to different types of joint forces will be made throughout the thesis as they apply to a Joint task Force (JTF), a Standing Joint Force Headquarters (SJFHQ), or a Complex Adaptive System (CAS).

dissimilar forces against each other (e.g. Helicopter gunships against ground based suicide bombers). It is a battle of networks, pitting advanced technological networks against each other in some cases and against simple, but evasive, cell phone and other similar communication networks in others. This complex environment is referred to throughout the thesis as network warfare, and includes "Wicked Problems" as a particularly difficult condition (Buckingham Shum, 1997). Such problems cause an equivocality to the hierarchical military organization, in which the pace of events exceed the organization's ability to sense, indicate and warn. This occurs due to the organization's inability to completely seed all space with sensors, resulting in intelligence gaps where organic sensors don't exist. This problem can be somewhat alleviated by increasing the number of sensing elements, the coverage of existing sensing elements, the fidelity of their connections, or the manner in which they are organized.

In his book "Fleet Tactics and Coastal Combat", Captain Wayne Hughes, USN (Ret.) identifies five great constants of combat that military force must employ to obtain immediate and decisive advantage over an equally maneuverable opponent. He specifies that the emphasis on maneuver, firepower, scouting, counterforce, and command and control are absolutely essential to achieve and maintain an advantage. Organizational and informational structures should be designed to integrate these elements, and should be capable of rapidly shifting resources and information as enabled by the physical network (Hughes, 2000).

Economic models offer similarities to warfare in a complex environment in that they also consider competitive advantage as critical to success. The author characterizes network warfare in economic terms with a definition provided by Credit Suisse First Boston (Maubossin, Schay, and Kawaja, 2000). The report states:

> Network effects exist when the value of a good increases because the number of people using the good increases. This network effect can be measured by two factors: interactivity and compatibility.

These factors are known in the computer world as Moore's Law and Metcalfe's Law. Moore's law addresses the interactivity aspects, and states that computer processing doubles every 18 months. Metcalfe's Law addresses the compatibility aspects, and

suggests that the effectiveness of a network grows exponentially as nodes are added arithmetically. In Metcalfe's words "When you connect computers together, the cost of doing so is n, but the value is n^2, because each of the computers you hook up gets to talk to all of the other machines on the network." (Maubossin, Schay, and Kawaja, 2000).

Another economic law further characterizes network effects; notably Arthur's Law named after noted economist Brian Arthur. The law is simple, stating that "of networks there shall be few". (Maubossin, Schay, and Kawaja, 2000). In a particular space, one network tends to dominate, while the rest fight over the scraps. Michael Cusumano and David Yoffie highlight this style of network competition in their book "Competing on Internet Time; Lessons from Netscape and its Battle with Microsoft" noting that 90% of all personal computers currently run a Microsoft operating system (Cusamano and Yoffie, 1998).

The effect of these laws on a military environment of network warfare is twofold. First, the computer laws of Moore and Metcalfe outline the power of a physical network, while simultaneously highlighting the need for designing interactivity and compatibility into the network. Secondly, Arthur's law demonstrates that a network is most effective when it works as a whole, leading to the supposition that a network-centric organization should be designed for a joint force, and not just a single service. Together these laws outline some of the benefits in transitioning to a network-centric organization to achieve the desired network effects of increased organizational effectiveness. The measure for determining this effectiveness is defined by the author as the ability of a network-centric force to dynamically adjust its resources to compete in a network warfare environment.

Transition to a network-centric organization may make sense from an economic viewpoint, but it must also pass a litmus test for its ability to conduct warfare better than the current hierarchical organization. The objective of this thesis is to demonstrate that a network-centric organization can be built that is matched to a dynamic environment more so than a hierarchical organization, and to outline the characteristics of the organization as they relate to the author's expectations for their performance.

C. RESEARCH FOCUS: CONCEPT OF A DYNAMIC ORGANIZATIONAL SCHEMA FOR A NETWORK-CENTRIC ORGANIZATION.

The objective of this research is to determine the interrelationships that organizational, informational, and physical architectures will have on Joint Force command and control of operations in an environment of network warfare. It discusses organizational characteristics as they apply to a transformation from a hierarchical platform-centric force to a network centric force. In particular, it will develop a network organizational concept using a multi-disciplinary approach to organizational structures, modeling these proposals from their perspective as a Complex Adaptive System (CAS). The questions this research will answer are:

1. Primary Question

What types of organizational characteristics and design parameters does a network-centric organization require, and what capabilities must that organization possess to best fit the proposed dynamic environment of network warfare?

2. Supplementary Questions

How will that structure accomplish current joint planning requirements?

D. THESIS ORGANIZATION

The methodology for this work is to outline the envisioned environment of netted warfare, and map organizational forms to required types of force actions. The literature examined includes that of organizational, complexity, informational and network theory, as well as long-range technologies that will affect the future of joint warfare. This research was conducted in conjunction with the Chief of Naval Operation's (CNO's) Strategic Studies Group (SSG) XIX and includes the effects of information on organizational theory and joint command and control as applicable to network warfare. SSG XIX research and findings as they apply to naval integration into a joint force provides the essence of this thesis.

A chapter summary is provided here:

- **Chapter 1 -** Introduction: This chapter outlines the environment facing the future joint force states the purpose of the thesis, scope of the thesis, and thesis organization.
- **Chapter II** – Organizational Characteristics: This chapter provides a primer on fundamental elements of organizational structure, and the relation of the structural characteristics to decision making in the organization.
- **Chapter III** - Organizational Structures: The network warfare environment previously discussed will define an architecture in light of three action types required to achieve the joint force commander's intent. This chapter compares and contrasts these action types to three possible organizational structures with particular emphasis on complex adaptive systems and discusses their advantages and disadvantages as they apply to the environment. These relationships will form the basis for a proposed dynamically configurable organizational schema. Central to this research was the networked-based organizational structure known as the FORCEnet, proposed by SSG XIX.
- **Chapter IV** – Joint Planning: This chapter explores the origins of joint planning, and outlines crisis action planning as it would be accomplished under the network-centric organization. Joint Command and Control (C2) structures are identified, and a command and control structure for the dynamically configurable organization is recommended.
- **Chapter V** – Organizational Modeling: This chapter will provides an analysis of the dynamic control by configuration choice with respect to a Joint Task Force (JTF), a Standing Joint Force Headquarters (SJFHQ) and a Complex Adaptive System (CAS).
- **Chapter VI** – Conclusion and Recommendations for future Research: This chapter offers concluding remarks and proposes areas of future research. It summarizes some of the key elements of the thesis, and highlights some of the characteristics envisioned for command and control of a dynamically configurable organizational schema.

II. ORGANIZATIONAL CHARACTERISTICS

This thesis developed from a need to define the organizational requirements of a network-centric force. SSG XIX and previous SSG's have identified a transition to network-centric warfare as a primary emphasis for future systems development, but little work has been done on how the myriad of sensors, unmanned platforms, and warfighters that the SSG envisions will be coordinated to achieve the commander's intent. The research in this thesis was developed to provide an initial assessment of the requirements for this organizational structure.

Research for this thesis included a review of organizational science to include classical, neo-classical and contingency organizational theory. Classical organizational theory generally focuses on the formal anatomy of an organization, and is built around pillars of division of labor, scalar and functional processes, structure, and span of control. Neo-classical theories introduced behavioral sciences into the classical theories, utilizing the same pillars, but expounding on the effects that the informal organization of human behavior has on an organization (Scott, 1961).

Contingency models of organization are an approach that hold that the appropriate form of organization and the best way to manage it is dependent (contingent) on the nature of the organization's environment (Tosi, 1984). Such models focus on environmental conditions and natural systems as having the greatest influence on an organization's structure. Burton and Obel use a contingency model to describe the fitness of a structure to the environment, and identify three criteria as paramount to organizational design (Burton and Obel 1998). These are:

- Effectiveness: An organization is effective if it realizes its purpose and accomplishes its goals.
- Efficiency: An organization is efficient if it utilizes the least amount of resources necessary to obtain its products or services.
- Viability: An organization is viable if it exists over a long period of time.

Complexity Theorists extend contingency theories to describe a fitness as "a dependence of an interacting cluster not only on its own state, but also of those to which it is linked" (Marion, 1999). This fitness identifies that the organization will not perfectly

match the environmental conditions, but should instead strive to maximize conditions across many areas, known as a Fitness Landscape.

Chapter II will provide an overview of the mission of the network-centric organization and then develop this using a well-known contingency model by Henry Mintzberg.

A. ORGANIZATION STRUCTURAL REQUIREMENTS

A commander may apply network dynamics to assist in deciding on courses of action. Moore's Law indicates that targeting command and control nodes are key to attacking a network that has centralized computing and processing spaces. Adversarial distribution and dispersal of the identity and location of the enemy command cells will provide one of the greatest challenges (Alberts, Garstka, & Stein, 1998). At the same time however, the same features organic to own forces will provide an ability to fight at lower risk compared to a centralized C2 organization, given measures of effectiveness remain the same or increase.

Metcalfe's Law indicates that the arithmetic destruction of one node should reduce the network potential by the square. By itself this suggests that offensive network warfare could focus on the destruction of nodes in a manner similar to attrition warfare of the Industrial Age. This option, while effective, is resource intensive, and does not consider the enemy's ability to rapidly reconstruct network nodes (that are often cheaper than the missile or gun round required to take them out). A more preferable option might be to disrupt enemy nodes and the network so that any more nodes added to the network would also be disrupted.

Deployment of a network centric force has costs that are different than those associated with building networks based on physical assets. Networks based on information assets tend to have high up front costs and low variable costs. A physical asset business (platform centric) for example, may have a 30% fixed/70% variable cost structure with a corresponding twofold rise in margins as output doubles. A network structure, on the other hand, may have a 90% fixed/10% variable cost structure, with a corresponding fourfold rise in margins as output doubles. Reinvestment on infrastructure

must also be considered in a full analysis, but a shift to a network centric force will ultimately yield a rise in potential output compared to investment (Maubossin, Schay, and Kawaja, 2000)

Application of networking and information technologies should vastly reduce redundancies and inefficiencies in daily operations through database management and associated data mining capabilities. More importantly however, they offer in even greater advantages to reforming organizational structure. Specifically the author believes that the ability to disperse and distribute combat power utilizing a dynamic organizational structure can result in an architecture that can rapidly sense, decide and act on targets of interest. SSG XIX research showed that use of manned and unmanned platforms and vehicles, united through networking technology, allowed the separation of combat power from the hull or platform, resulting in greater coverage and survivability factors. This in turn shifts the point of organizational decision making such that layers of command can be eliminated from organizational structures, resulting in an increase in operational facets of art such as speed of command and synchronization. Vice Admiral (VADM) Cebrowski describes this when he states " It allows us to move from an approach based upon the massing of forces to one based upon the massing of effects (Cebrowski and Gartska, 1998). The commander will determine what structure is best fit to achieve his intentions, rather than just relying on a traditional hierarchical structure.

In his book 'Hyper-Competition: Managing the Dynamics of Strategic Maneuvering" Richard A D'Aveni says that traditional approaches to competitive strategy stressed "creation of advantage." To achieve these, efforts focused on building and maintaining advantage through economies of scale, best distribution systems, cutting edge Research and Development (R & D), deep pockets and other features that gave them power. These features raised barriers to entry that seemed impregnable, and the strongest players survived (D'Aveni, 1994). With the development of worldwide networks and globalization of markets however, an alternative view that strategy must also be the creative destruction of the opponent's advantage has emerged. Generally speaking, a force must be capable of rapidly switching between offense and defense, as the direction of attack will not always be clearly obvious. The US National Security Strategy (NSS)

recognizes this as it outlines reasons for a pre-emptive offense to provide a good defense against terrorist networks.[4] This will not always come in the form of overt military action, but rather in more covert tasks and opportunities. Network warfare may be considered as the natural extension of hyper-competition, and it describes the ability of one organization to compete against another, utilizing both offensive and defensive methods to gain competitive advantage. For the military force that will use it, the author defines it as "the use of nodal posturing and targeting to achieve distribution and dispersal of forces in a network and application of command and control to achieve related and desired effects across the network."

To create advantage against a competing force in hyper-competitive conditions, D'Aveni recommends the use of four steps based on dynamic strategic interactions (D'Aveni, 1994). They are:

1. Disrupt the status quo: Apply speed and surprise, as they are the capabilities for disruption. For the sake of this discussion, the application of these capabilities is not just associated with increasing the efficiency of current processes. To achieve speed in hypercompetitive conditions, organizational structure must be reworked to allow for rapid decisions and actions. Processes within the organization change, as does the culture. The organizational structure becomes flatter, more team oriented, and the rigid and slow hierarchical structures of the past are replaced.
2. Creating temporary advantage: Apply the rapid decision making capabilities of the flatter organization to quickly respond to market or environmental conditions. Move light forces rapidly to achieve position. Analyze the new situation and determine suitability for further pursuit.
3. Seizing the Initiative: Like Capt. Wayne Hughes Jr. USN, (Ret.) before him, D'Aveni reemphasizes that advantage in hyper-competitive environments goes to the one that can fastest exploit opponent's disadvantages (Hughes, 2000). Winners set the pace through positioning of forces, and application of

[4] United States National Security Strategy, September 2001.

command and control to control forces at precise moments. The commander's challenge is to identify the actions required for the hyper-competitive conditions, and then organize to ensure those actions are facilitated.

4. Sustaining the momentum: True advantage will be sustained through a three step process:
    - Stay ahead of the competition in each arena of competition
    - Restart the cycles within each arena
    - Jump to a new arena that was previously not the main focus of the industry.

The most "Wicked Problem" that the Joint Force currently faces is how to conduct war in continual hyper-competitive conditions in remote sites without assured access. This problem was presented to SSG XIX for research and review, and they determined that one of the reasons this is so difficult is due to planning factors of positioning forces against constraints of range, time, and money for continuous contingency crisis situations. Creation of competitive advantage requires rapid reallocation of correct forces, coordinated via means of logistical, command and intelligence networks. The SSG XIX report identified a need for the Navy (and hereby extended to all Services) to invest heavily in network technology to control a vast field of manned and unmanned sensors and weapons. Central to achieving and maintaining this force is the network itself, and a dynamic organizational structure that can rapidly assess, decide, and act on global threats. It requires dispersed forces capable of responding to a regional crisis utilizing fighting networks, as called for by the Joint Chiefs of Staff Joint Vision 2020. D'Aveni sums this concept up nicely when he says "In a dynamic world, only the dynamic survive".

B. CHARACTERISTICS

1. Overview

The concept for a dynamic organizational schema for a network-centric organization begins with an analysis of organizational characteristics.[5] These elements were selectively outlined by Henry Mintzberg in "The Structuring of Organizations" where he introduces structural aspects of an organization only after considering the basic elements the organization must facilitate. He identifies these elements as the building blocks to an organizational architecture, as well as supporting generic and specific design criteria (Mintzberg, 1979).

Mintzberg identifies six basic parts of an organization, related through six coordinating mechanisms. These form the basic structural elements of any organization, and they may be tailored through complementary design and contingency parameters. His model provides an excellent grasp of fundamental organizational attributes, and will be used in this thesis to build the organizational architecture for network warfare in the littoral. The design and contingency parameters are particularly noteworthy in this discussion, as they are the link between form and function, uniting the organizational architecture to the purpose for which it exists.

The organizational architecture for the dynamic organizational structure outlined in this thesis is proposed in terms of Mintzberg's six parts, the relationships of which are identified by the six coordinating mechanisms. For command and control of a network-centric force, the fundamental question is whether these relationships will be the same, or different, and how they will evolve. The following paragraphs will outline the elements to this question, and then discuss them in terms of their application for joint force C2. Design parameters and contingency factors will also be considered, and used to formulate the organizational architecture.

[5] The organizational characteristics and design parameters are herein referred to as being part of an "organizational architecture" which itself refers to the structure of the organization.

2. Six Parts of an Organization

Mintzberg (1979) states the six basic parts to an organization as:

1. Operating core
2. Strategic Apex
3. Middle Line
4. Technostructure
5. Support staff
6. Ideology

He proposes that these parts are prevalent in all organizations, and the dissection of them allows conclusions to be drawn as to the criticality of each to the organizational architecture in review. A shift in objectives, strategy, or technology may require or enable an organization to correspondingly shift emphasis in the parts to achieve greater efficiency, as specific organizational types fit best with emphasis on one part more so than the other. To build the organizational architecture, each part must be examined, and tooled to the required coordinating mechanisms. This section will discuss organizational characteristics, applying operational naval examples from SSG XIX research to illustrate their relationship to a network-centric force.

a. Operating Core

The operating core is defined as the area of the basic work of producing the organization's products and services (Mintzberg, 1979). For the operational Navy, the author defines the operating core is the ships, submarines, airplanes, and sailors, as well as a host of other peripheral elements. Essentially the SSG XIX report does not envision a change to this fundamental core but it may change in appearance. The only foreseeable alteration to this would be an increased naval presence in space, but this is not forecast at this time. The operating core may change in appearance however, as the Navy envisions a large number of unmanned vehicles to complement manned platforms. This shift will significantly alter the organizational architecture of the Navy, allowing it to disperse and distribute combat power much more effectively than it is currently.

b. Strategic Apex

The strategic apex is defined as the location of the top management, and considered for this thesis' purpose as the JTF Commander at the operational level of command (Mintzberg, 1979). While the shift from a platform centric to a network centric force may also shift the location of the commander, it is not envisioned that the function of command will disappear. Witness the use of remote Unmanned Aerial Vehicle (UAV) command modules during Operation IRAQI FREEDOM (OIF) (Schmitt, 2003). While the UAV's flew missions over Iraq, they were controlled via terminals located nearly 7,000 miles away. Despite the distance, a human remained in the loop, enabled by information technology to impact events from disparate locations. Command in military operations therefore, is an enduring requirement for it is the human interface to war. This is an important assumption to note in this thesis as it holds command as essential to the military organization (Maguire, 2000). While a number of cyber warfare experts may suggest that war in the future will be across computer networks, a more practicable supposition is that the organizational architecture must support the function of command as much as it does today. This functionality will be discussed more at the end of this chapter, and will consider the impact that the informational and physical architectures will have on it. The effect on the strategic apex will be primarily twofold. It will allow information technology to drive away the requirement for the commander to be tied to a physical location, and the collaboration and networking of forces will require the strategic apex to concentrate more on ensuring connections are established rather than confining forces to certain locations or missions.

c. Middle Line

Middle line is defined as the managers in the direct line relationships between strategic apex and operating core (Mintzberg, 1979). The authors defines middle managers as the action officers and enlisted that supply the leadership and perform the massive amounts of information processing that are routed to the central battlegroup staff. Their purpose is to operate sensors and weapons in support of the operational commander, with secondary collaboration between each other. It is the author's opinion

that the middle line managers in the military are stoically slaved to the hierarchical structure they are organized under and superficially capable of collaborating both intra and inter service. These qualities will need to drastically change to enable a network centric shift, and will significantly impede the effectiveness of the organizational architecture if they are unable to be implemented.

d. Technostructure

The Technostructure is defined as the staff analysts who design the systems by which work processes and outputs of others in the organization are formally designed and controlled (Mintzberg, 1979). The levels of bureaucracy inherent in a traditional, hierarchical military organization runs counter to the requirement for faster decision making and empowerment of individuals. A shift to a network centric force should reverse this dilemma, but full effect may be difficult to achieve as bounds cross outside of military commands. Network centric operations will have a complementary, positive effect for both the warfighter and the Technostructure however, giving each the power to exchange information across the network on a reciprocal smart push, user pull basis. The limitation in organizational effectiveness then becomes the capability for interaction and therefore is a primary focus of the network centric command.

e. Support Staff

The support staff is defined as all the specialists who supply support to the organization outside of its operating workflow (Mintzberg, 1979). Associated military and civilian intelligence, supply, and administrative agencies comprise the support staff that assist in gathering, processing and disseminating data and information that is used by the middle line managers. Until recently, most intelligence is fed to the warfighter on a time late basis, but generally in actionable form. SSG XIX envisioned an advanced military network where data is gathered real time and is processed locally onboard the sensor, or with the assistance of network intelligence cells. This information will then be immediately available for follow on tracking or targeting. As this capability evolves, the organizational architecture must allow for it to remain actionable by assigning

appropriate decision making authority to the processing point. The hyper-competitive conditions of network warfare will demand that information not be restricted to the traditional command and control hierarchical structure.

f. Ideology

Ideology is defined as the halo of beliefs that surrounds the whole organization (Mintzberg, 1979). Military operations are fundamentally based on doctrine and strategy that is part of a whole, designed to complement a national security strategy and national military strategy (Joint Pub 3-0, 1995). Each of these must be supported by the organizational architecture in the same way it is today. In addition, there are a number of other elements of ideology that must be incorporated and supported, including the Uniform Code of Military Justice (UCMJ), joint warfare doctrine and education, rules of engagement and conventions of war. These are designed into current operational organizations and this thesis assumes that the proposed network centric organization will use them also.

3. Six Coordinating Mechanisms

These six elements provide the basis for organizational architecture dissection, and are relevant when also considering the coordinating (control) mechanisms that tie them together. Mintzberg (1979) identifies these mechanisms as the following:

1. Mutual Adjustment
2. Direct supervision
3. Standardization of work processes
4. Standardization of outputs
5. Standardization of skills
6. Standardization of norms

a. Mutual Adjustment

Mutual adjustment is defined as the means to achieve coordination of work by the simple process of informal communication. (Mintzberg, 1979). It is the essence of self-synchronization and adaptive behavior. Mutual adjustment is an absolute

necessity for operations in network warfare and littoral environments. Mutual adjustment is often seen within military operations when a plan breaks down, and options diverge. Today, mutual adjustment tends to be effective because forces train together and understand the manner in which future action can be expected. In situations involving new players, such as in a coalition exercise, mutual adjustment cannot be assumed, and forces will need much more reassurance to determine appropriate actions. Networking and collaboration are essential elements to mutual adjustment, and need to be emphasized throughout the organizational architecture.

b. Direct Supervision

Direct supervision is defined as the coordination achieved through the direction of a hierarchical leader (Mintzberg, 1979). Prevalent in military operations today, direct supervision benefits an organization by ensuring tight controls and resolute behavior. In some cases it can be the fastest method of achieving an objective, but in other ways accompanying bureaucracy may slow it down. To the extent that this bureaucracy may be minimized, direct supervision is an effective coordinating mechanism for military operations. Span of control is usually the dominating factor that determines the level of direct supervision, with greater span of control equating to lower levels of direct supervision. The future informational and physical architectures will provide greater span of control to individual commanders, and may allow for significant reductions in the layers of middle managers required providing direct supervision. The benefit to this, besides the reduction in manpower, will be that forces can organize through a network that appears loosely coupled, but still has the potential to achieve the deterministic effects characterized by a hierarchy.

c. Standardization of Work Processes

Standardization of work processes is defined as directly follow given procedures (Mintzberg, 1979). Operational planning provides the basis by which a Joint Force conducts standardization by method of work processes. While plans are expected to have flexibility built into them, the role of planning defines the manner in which forces

standardize their procedures that eventually appear in practice. Future network capabilities will fundamentally alter the planning process that has evolved over the last 50 years, allowing rapid, on the fly planning with real time simulation and gaming. As this occurs, it can be expected that the planning process today that standardizes military actions will give way to a creative process more closely aligned with mutual adjustment.

d. Standardization of Outputs

Standardization of outputs is defined as giving an objective(s) to subordinates to attain required results (Mintzberg, 1979). This control process is used essentially in the middle management level. While it seems as if the massive inspections and regulations exist to ensure that standardization occurs along written rules and processes rather than desired outputs, commanders have the ultimate responsibility for unit output. An organizational architecture built for a network centric force will allow an increased progression towards a standardization of outputs due to real time monitoring and knowledge transfer. It may also have the reverse effect of allowing too much micro-management however, prohibiting the middle managers or operating core form having the leeway to achieve the stated objectives at their own pace.

e. Standardization of Skills

Standardization of skills is defined as individuals trained to act in a particular manner to achieve results (Mintzberg, 1979). Coordination is achieved by virtue of various operators' having learned what to expect from each other. In a way, similar to mutual adjustment in that close interactions allow each force to more readily anticipate each other. The difference is in one of preparation, as mutual adjustment allows for unknown entities to collaborate together. Standardization of skills on the other hand, allows an uninitiated force to have certain expectations of another however, without necessarily having attained the level of interactions prevalent in mutual adjustment. A battlegroup staff is a good example of this type of standardization, as a certain level of competence is expected due to the referent authority of the people on the

staff. Further, in this example, all does not rest on the shoulders of one individual, and another readily compensates for a failure by another.

f. Standardization of Norms

Standardization of norms is defined as workers sharing a common belief/goal, through which coordination is achieved based on it (Mintzberg, 1979). This control process is essential to any military operation, and relies on leadership that can inspire troops to accomplish a mission. This area is well defined in today's military, instilled in boot camp, and reinforced on a daily basis through physical interaction with fellow sailor's. At the other extreme, it is not at all prevalent in a cyber command and control scenario, as it may be impossible to determine the intentions of the person at the other end of the network. This provides a very difficult and dangerous situation for military operations in cyberspace, and will require dedicated assets that are fully synchronized through external communications.

4. Effects of Parts and Coordinating Mechanisms on the Organizational Structure

The organizational architecture required for a shift from a platform centric to a network-centric organization may be framed from the six characteristics that Mintzberg proposes a platform-centric organization places great emphasis on the strategic apex and middle line to set and enforce goals and objectives. A network-centric force, on the other hand, places greater emphasis on the operating core, placing authority and responsibility closer to the point of action. Each relies on a support staff, although the network-centric force ties the support staff closer to the operating core, requiring a seamless transition of support to actionable knowledge. The Technostructure is both an asset and a liability to the network-centric force, but it must be established and reinforced through redundant and robust networking. Ideology for the network- centric is a critical attribute as it is the glue that holds the nodes together, and provides needed positive reinforcement to support commander's intent.

A shift in emphasis will also be required for the coordinating mechanisms. Today the primary emphasis is on direct supervision in a hierarchical structure. For example,

while effective for a platform-centric Navy and an environment that permits sequential actions, it is near impossible to use effectively by itself in a network-centric and highly complex environment. Warfare strategy in network warfare will have to be formulated closer to the point of action, among a variety of actors, and be capable of attaining swarming effects (Arquilla and Ronfeldt, 2001). Direct supervision in a network centric force will succumb to intelligence gaps, leading to periods of uncertainty and equivocality. Not being aware of information (equivocality), or being unsure of its veracity (uncertainty) leads to gaps in situational awareness that may prevent direct supervision from effectively organizing network forces for the conflict (Alberts, Garstka, Stein, 1998). The network-centric forces will thus shift from direct supervision to one that is coordinated through mutual adjustment and standardization of outputs. A commander will broadcast his commander's intent, and once on the network, it will be available to naval forces to interpret. These same forces will determine the optimal manner in which to achieve his intent, in a manner similar to how markets work today. The large number of dispersed and distributed vehicles proposed by SSG XIX will allow a force to utilize their capabilities as part of the network, rather than as part of a particular platform's combat capability.

Other coordinating mechanisms will see an increased reliance as well. Increased emphasis on standardization of skills and standardization of norms will allow a networked force to plan operations on a collaborative basis, and will increase the applicability and timeliness of the plan due to real time connectivity. In other words, disparate forces can plan and conduct large-scale operations via the network without physically meeting. This capability will rely on the standardization of skills and norms to provide the basis for expected action, a quality usually determined through physical interactions and experience. The greater the ability to achieve real time planning and operations, the greater the increase in synchronization and speed of command will result.

a. Design Parameters

Given these organizational parameters that Mintzberg outlines, there are certain design parameters that can be associated to achieve the desired organizational

effectiveness. Mintzberg lists nine such parameters, of which only a few will be discussed here. Specifically, this discussion will focus on decentralization/centralization, unit grouping, unit size, and liaison devices. These parameters will be used in later chapters to analyze effects on Joint Force C2 organization.

b. Distribution and Dispersal

The proposed organizational architecture in this thesis is one that will enable a network-centric force to organize at the unit level, but then quickly scale to achieve larger, devastating effects. Today, this type of structure exists in a very rigid form, as each platform may function by itself, but is organizationally a part of a larger force structure. This is clearly evident in the naval battlegroup organization where each ship, submarine, and airplane has both an administrative and operational chain of command. These chains are designed to focus emphasis on a particular aspect of naval operations, but often work independent of each other. Within the battlegroup structure the system works well, as the organization is well developed by the time it deploys. This is only possible though, by means of an extensive workup period in which the individual units develop together within the confines of the given task. Addition of a new unit resets the learning curve, as does the transfer of an integrated unit to a different battlegroup. With the proposed force structure including many forms of manned and unmanned vehicles, there will be little opportunity to work together on an extensive basis prior to deployment, especially given the envisioned continual contingency operations. Rather, forces will arrive in an Area of Responsibility (AOR) rapidly and fully plugged into the network. As they do, they will supplement coverage with sensor and weapon systems that may be readily tasked by others in the network. There is no way to know who will be tasking these unmanned vehicles, and as such the requirement to train with a specific battlegroup is non-committal. Rather, these types of forces will require less training together, instead capitalizing on rapid network integration, the informational replacement for the support staff. This indeed is one of their primary advantages.

A network centric force therefore, would have the ability to transparently move in scale, from individual unit to theater level integration. This architecture would

align forces as they are available and required, rather than present day methods of establishing temporary organizations comprised of joint services with different supply, administrative and supplementary operational chains of support. It will enable distributed combat power that is required for the complex environment, and will allow forces to roam assigned areas with network centric connections. Distribution of combat power is accompanied by a distribution in command and control, enabling forces to seamlessly integrate at point of action vs. point of origin. Network connections allow command and control to dynamically adjust much like an on-scene commander at a Search and Rescue (SAR) site, reallocating SAR areas as more forces join the effort.

c. Centralization vs. Decentralization

Nielson, Paternack and Viscio from Booz-Allen Hamilton have developed a seven dimensional model for the "E" Organization, proposing that the organization chart is a relic of the past, replaced by a centerless Enterprise model. They believe that information and networking technologies are allowing organizations to shift from bureaucratic, hierarchical structures to flexible, decentralized team and alliance based organizations (Nielson, Pasternack, and Viscio, 2000). The organizational model is built around a strategic global core, working with market facing units, and coordinated with shared service networking. Such a model uses both decentralized and centralized connections. Mintzberg (1979) discusses centralization and decentralization as it relates to decision making, and it is particularly applicable for the issues this thesis considers. He states the difference between the two as " When all the power rests at a single point in the organization, we shall call the structure centralized; to the extent that the power is dispersed among many individuals, we shall call the structure relatively decentralized."

The centralization/decentralization/ deliberation lies at the heart of the organizational architecture. It is the key design parameter as it reflects a new decision-making environment that is required by network warfare. Current force structure is highly centralized, with the power resting at the strategic apex. The joint force commander for example, receives inputs from his forces, determines the nature of the problem, and then decides on appropriate courses of action. This method may scale down to local command

levels, but it does not shift the source of power as much as a decentralized structure would. As a design parameter, the level of decentralization needs to be appropriate for the environment, and is contingent on a few related situational factors.

Generally speaking, the more dynamic the environment, the more organic the structure, where organic describes a non-standardized structure. Additionally, Mintzberg (1979) specifies the following factors related to the environment:

- The more complex the environment, the more decentralized the structure
- The more diversified the organizations' markets, the greater the propensity to split it into market based units, or divisions.
- Extreme hostility in its environment drives any organization to centralize its structure temporarily
- Disparities in the environment encourage the organization to decentralize selectively to differentiated work constellations.

Decentralization is required when one brain is not enough and cannot understand all that must be known. It allows an organization to respond quickly to local conditions in many different places, and it can serve as the stimulus for motivation, since capable people require considerable room to maneuver if they are to perform at full capacity. "Centralization, on the other hand, has one great advantage in the organization. By keeping all the power in one place, it ensures the tightest form of coordination. All the decisions are made in one head, and then implemented through direct supervision (Mintzberg, 1979).

The command and control structure needs to be able to utilize each of these advantages as required by the environmental situation. Using Mintzberg's description, the elements of a decentralized structure will suit situations that are dynamic and complex, whereas stable and distinguishable situations will be best addressed through hierarchical, centralized C2. Decentralized command and control will be emphasized in periods of dynamic situations, and where assets are quickly mobilized. Centralized command and control will be emphasized in periods of stability, or when focused effort best satisfies commander's intent. The Joint Force Commander must prepare operational forces for each of these possible environments.

The extent to which an organization may consider itself decentralized varies with the six coordinating mechanisms. The environmental requirements should drive the level of decentralization, although it may be constrained by the other situational factors of age, size, or technical systems. A highly complex environment calls for an organizational architecture that places decision-making in the hands of experts that work in small groups. These small groups are best able to respond and coordinate at local levels to achieve global results in line with the commander's intent.

According to Mintzberg (1979):

> The six coordinating mechanisms relate directly to the level of decentralization achieved as they specify the location of decision-making power. Direct supervision is extremely not decentralized; rather it is centralized with all of the decision-making accomplished at the strategic apex. Standardization of work processes pushes some of this decision making down from the strategic apex, but only in the sense that the analysts who control the design of the systems of standardization attain some power. Standardization of output allows power to be distributed over many decisions to managers of market based units, resulting in a form of vertical decentralization. It is limited though as only a few managers retain the majority of power. Standardization of skills places power at the operating core, but relies on extensive training and self-motivation to allow decision making at the bottom of the hierarchy. In a similar manner, mutual adjustment places decision making power in the operating core, but relies on interactions between managers and non-managers to share power and information. Decisions are controlled by the person/group who has the necessary expertise. The final coordinating mechanism, standardization of norms, results in a completely decentralized architecture. Ideology forms the root of this form, and that allows fully decentralized decision making based on the belief that members will act in accordance with prevailing norms.

Applying these coordinating mechanisms, the organizational characteristics for a network centric operational command and control can be identified as they relate to decision making. If the mechanisms are the same as a platform centric force, the organizational architecture will not need to be altered. If however, they are different, a new architecture will need to be considered to match these requirements.

The hierarchical organization requires standardization of outputs and standardization of work as a desired end state from its command and control functions.

Decision making in the current platform centric force structure is primarily controlled by a unit's commanding officer through verbal and written communication, thereby determining the work processes that the subordinate employs. In a way also, external agencies such as acquisition managers constrain the work processes by setting rules to go with equipment, but for the most part they are there to protect long-term organizational interests. Standardization of outputs is employed through a current military hierarchy specialized to meet a given task such as Undersea Warfare (USW) or mine clearance. If operating outside of that environment then the individual specializing in one task cannot be assured of making the correct decision for another. As one may guess, neither of these levels of decentralization reflects the required point of action decision-making capability that will be required for the complex environment, or enabled by the military network. Therefore, it may be assumed that a shift from this type of decision making will require that the organizational architecture be adjusted from present day form.

Standardization of norms is currently used by the military services today, but it is only emphasized at more senior levels. Professional military education, for example, tends to be emphasized at the 0-4 level and above. As more and more officers and enlisted receive this education, the greater the ability to achieve standardization of norms, especially in inter service operations. Having this education empowers the individual to feel confident in his decision-making, and allows experience levels to be partly subsidized by education. Additionally, joint and coalition operations will become more fluid, allowing for looser coupling at initial planning stages due to greater decision-making at lower levels in the operating core.

Standardization of skills is another method of empowering decision making in the operating core. It also has the added benefit of building confidence among middle managers and the strategic apex by building a stronger foundation of expertise at lower levels. This is achieved primarily through advanced technical education, and advanced warfighting training and skills refinement.

Mutual adjustment allows for hierarchical controls while minimizing their requirement. Point of action information is exchanged throughout the operating core, and can be reciprocated back and forth through liaison devices. Mutual adjustment is adaptive

in nature, but does not prohibit external communication and command. It provides what Mintzberg refers to as vertical and horizontal decentralization, where vertical decentralization is the delegation to work groups at different levels in the hierarchy and horizontal decentralization is a varying distribution of power within each group of managers and non-managers (Mintzberg, 1979). Mintzberg points out that mutual adjustment and direct supervision are related in the sense that they are both organic structures; that is, they are relatively free of standardization. A structure is bureaucratic, on the other hand, to the extent that it relies on standardization for its control processes. (e.g. a heavier reliance on standardization indicates increased bureaucracy). Today's command and control relies on standardization of output and work processes, implying bureaucracy. These processes need to become more organic for the envisioned dynamic environment and associated requirement for crisis action planning.

Accepting Mintzberg's description of organizational parameters, and applying it to the complex environment of network warfare, it is apparent that characteristics of direct supervision and mutual adjustment should be the predominant coordinating mechanisms utilized by the organizational architecture. These, coincidentally, are also proscribed by complexity theory for dealing effectively in a complex environment (Marion, 1999). Other supporting mechanisms such as standardization of norms and skills should be utilized if only for the large size of the organization, whereas standardization of outputs and work processes are alternate means of achieving decentralization at different levels (Mintzberg, 1979). In summary, greater emphasis must be placed on moving towards mutual adjustment and standardization based on skills and norms for complex environments, whereas a continued emphasis on direct supervision and standardization of outputs and work processes will be preferred for less complex environments.

d. Grouping

Direct supervision and mutual adjustment are the primary characteristics of the proposed dynamic organizational schema; therefore certain design parameters have greater applicability to the organization's structure. Unit grouping, for instance, affects

both in similar manners. Mintzberg defines grouping as a fundamental way to coordinate work in the organization, and he subdivides it into two levels, functional and market based. Functional includes grouping by knowledge, skill or work processes whereas market includes grouping by output, client, or place. The general difference between the two is a focus on means (functional) vs. ends (market). Both have the same focus on achieving the end result, where functional grouping aligns hierarchically, and market grouping aligns to directly network the seller to the consumer. Direct supervision and mutual adjustment are favored under market based grouping where there is a tendency to reduce the degree of bureaucracy. As Mintzberg observes "in general, market grouping reduces the ability to do a specialized or repetitive task well and is more wasteful, being less able to take advantage of economies of scale and often requiring the duplication of resources. But it can do more tasks and change its tasks more easily to serve the organizations end market" (Mintzberg, 1979).

e. Unit size

Mintzberg also found that the greater the need for mutual adjustment, the smaller the size of the work unit should be (Mintzberg, 1979). He defines the need for mutual adjustment as based on the complexity of the task and the level of coupling associated between them. Complex and tightly coupled tasks, such as a fire control solution among cooperating platforms, will require greater emphasis on mutual adjustment. This is a significant point to explore, as it will determine the size of the network that will most effectively counter a threat. In some cases the network will need to be large, but in others, such as the fire control example, the network will need to remain small for mutual adjustment to work effectively—typically less than ten people, and often on the order of five, six, or seven.

f. Liaison Devices

The problem that arises with grouping however is it tends to discourage interunit communication as it encourages intraunit communication. This would have devastating effects on a naval organization that is organized in small groups that must

come together to scale operations. To achieve the desired scalability in a mutual adjusting force, Mintzberg (1979) points to the use of four liaison devices that may be used, ranging from temporary to permanent structures. These devices function as a bridge between cells, allowing the organization to benefit at both local and global levels.

The four devices he identifies are:

1. Liaison positions
2. Task forces and standing committees
3. Integrating managers
4. Matrix organizational structure

A commander may employ each of these devices as required in order to create synchronization of forces in the complex environment. These liaisons are given the authority to collaborate with each other, while operating within the confines of the hierarchical system. Information Age technologies will allow grouping in the form of command and control collectives that will form for the purposes of mutual adjustment. These C2 Collectives have been proposed in SSG XIX as collaboration cells that are designed or developed with the direction outlined by the strategic apex and staff ideology. Due to the distribution of combat elements, the C2 structure will have the capability for this type of group formation, but will often require some type of catalyst to encourage their formation. This catalyst must come in the form of a liaison device that will function to identify elements that should be communicating to each other, as well as to process outputs among other liaison devices. It is possible that these groups and devices may emerge through network enabled connections, and that a temporary structure would be favored over a permanent one for the early stages of an operation.

5. Dynamic Organizational Schema

The dynamic organizational schema that this thesis proposes for future joint warfare is now beginning to unfold. The dynamic conditions that thus drive network warfare also drive the necessity for an operational commander to be able to dynamically change the manner in which the forces are organized. There is a requirement for mutual adjustment in the early stages of a scenario of network warfare planning, and warfighters

should be grouped together in small units that are loosely coupled. As the scenario develops, these small units, by virtue of their mutual adjustment and virtual connections, will align forces and resources to increase fidelity on decisions. They are united through the guidance of the commander's intent, and assisted through liaison devices that encourage collaboration with outside sources. As these forces address the developing scenario, information is developed into mission analysis from which courses of action may be developed. Depending on conditions, the commander may find that a loosely coupled organization is better suited to accomplishing the commander's intent, and as such, must be permitted to have loose controls and maximum communication between force elements. On the other hand, a commander may be better to limit interactions so as to focus efforts in a particular direction. This may occur through direct input from the commander, as an adaptive adjustment to the environment, or from emerging anticipation of future events.

Directive, adaptive, and emergent actions are optimized under different organizational structures and require the commander to adjust his methods of command and control focus to achieve his intent. The commander must employ a variety of tools using a dynamic organizational schema to achieve this, as no single structure or command and control method will suit the range of tasks that a force must accomplish. These actions and structures will apply to interact seamlessly, and with devastating effect. The goal as outlined by SSG XIX is to integrate the network of people, platforms, vehicles, weapons and sensors into actions, and present an offense in depth to continually disrupt the status quo, create temporary advantage, seize the initiative, and sustain the momentum (D'Aveni, 1994).

Critical to this new control system is the assumption that the organization has accepted the attributes associated with building an Infostructure as outlined in Chapter One, and proposed by SSG XIX as the FORCEnet. These systems have the potential to provide rapid advances in decision making speed and implementation, but can not be allowed to function void of some rule sets however. Placing decision making closer to the point of action yields the propensity for quicker decisions, but also increases the risk of the quality of the decision. Stan Davis of the Ernst and Young Center for Business

Innovation identifies that the design of a knowledge management system must incorporate the tradeoff between speed and risk, and must tailor that tradeoff to the mission and environment of the organization (Davis, 2001).

In essence, an informational architecture must exist that will build on the experiences of others, aid in decision-making, and provide feedback. In their article, "Steal this Idea" Jan Torsilieir and Chuck Lucier recommend two dependent guidelines for informational architectures. First, collaboration amongst people in the organization is essential to decision quality, encouraging shared ideas, dialogue and access to knowledge. Second, there must be a way of quantifying these efforts and decisions to turn them into actions designed to accomplish the mission. The first guideline requires broad cultural change, and the second guideline provides the big results required for enduring change. Both of these elements are key to implementing an informational architecture that can serve as a decision aid, as well as enabling a force that makes more decisions at the point of action, rather than through a chain of command (Torslieir and Lucier, 2000).

C. SUMMARY

The author's proposal for a network-centric organization requires that the organization be capable of dispersing and distributing combat power utilizing a dynamic organizational structure that can rapidly sense, decide and act on targets of interest. These requirements were outlined in the concept of Network-Centric Warfare discussed in Chapter I, and their relationship to the envisioned environment of network warfare were proposed as reasons for a network-centric organization. The network warfare environment was further developed along Richard A D'Aveni's approach to hypercompetition, and the creation of competitive advantage was explored to re-emphasize the need for the application of dynamic strategic interactions that the organization needs to accomplish to be effective. A Dynamic Organizational Schema was then outlined using Henry Mintzberg's Contingency Model for organization, with a definition and application of each of the model's characteristic and design parameter to the network-centric organization.

III. ORGANIZATIONAL STRUCTURES AND DESIGN PARAMETERS

To build the integrated organizational architecture required for C2 of a network-centric force, organizational structures must be reviewed and possibly reconfigured. This chapter will provide an overview of the organizational requirements that a joint force must encompass in order to handle the hyper-competitive conditions of network warfare. It will describe them in terms of chaos and complexity theories. These theories describe highly dynamic environments and methods by which objectives can be met in such conditions. It assumes that a network-centric technostructure is in place that unifies the organizational units discussed in the previous chapter.

A. CONTINGENCY FACTOR IMPACTS ON ORGANIZATION AND C2

Decisional uncertainty and equivocality develop from a lack of knowledge or understanding of the environment. The author believes that this will characterize network warfare, and will be aggravated by the speed and security of an opponent's information. Commanders must be able to effectively command and control in the conditions of network warfare, structuring their force at the organizational level to deal with the developing environment. The author has proposed that the network warfare environment and available information technologies are contingency factors that are driving the reformation of US military organizational structures. Senior Department of Defense leadership such as the Secretary of Defense (SecDef) and VADM Cebrowski of the Defense Transformation Office echo this sentiment. Contingency organizational models such as Mintzbergs are then applicable to analyze organizational structure along these factors, where the contingency factors are viewed as independent variable, and the structural variables and design parameters are the dependent variables.

1. Classical Organizational Theory as a Function of Technology

Mintzberg's hypothesis that "effective structuring requires a consistency among the design parameters and contingency factors" (Zahrly, 1984) was preceded in another study by Joan Woodward and her associates (Woodward, 1965). That study provided strong evidence that there is no one best way to organize (Tosi, 1984).

Woodward studied 100 firms in an industrial area in attempting to test the utility of classical management theory. In an abstract by Charles Perrow (1970), Woodward's study and findings are summarized where he states:

> The purpose of the study was to identify whether types of organizational structure, span of control, or number of hierarchical levels had any particular relevance to organizational success. The results were startling, as she found that only after the firms were grouped according to their typical mode of production, was there any linkage. The linkage was that firms with similar production systems had similar organizational structures, despite the variety of the products involved. In a simplified summary, she used three types of a production system: unit and small-batch, process production, and large-batch assembly, otherwise stated as a unit, process, or mass. She described the whole scale as roughly equivalent to increasing technical complexity. But the most important conclusion is that there is no evidence to prove that sales, production or development is the most important in all organizations. The importance of a function depends upon the specific technology employed.

Mintzberg's theory proposed that organizational structure is composed of certain characteristics, united through design parameters to conform to contingency factors. Woodward's theory that no single element is the most critical (assuming that the organization needs all of the elements) argues that no single method of organizing is effective and that the technology employed impacts the function. Taken together, these theories were used in SSG XIX research to propose that no single organizational structure would be sufficient for a network-centric organization. Since networks may be designed to be easily re-configurable by adding nodes or connections, the proposal for this thesis is that such an organization is desirable for the military commander, as dynamic warfare environments require different functions of the same warfighters. Warfare in the 21st Century has required Commanders and military forces to rapidly adjust between warfighting and peacekeeping missions, and the organizational structure these forces operate in must rapidly respond to these environmental changes.

2. Emerging Organizational Functionality

The proposal then is that no single structure will suffice in all situations of certainty, uncertainty, and equivocality, and during crisis action planning. The author

offers an extension to this proposal that the network-centric organizational structure should function for three types of actions: Directive action, Adaptive action, and Emergent action.

These three types of action cross the range of actions that a commander and staff might desire for their command and control capability. Each has its own advantages in a conflict situation, and the commander must tailor the desired action type to each evolving situation. Then, the organizational structure must be designed to flex to implement the action required.

Table 3.1 shows an ideal relationship among an environment or condition that is considered to have certainty, uncertainty, or equivocality in regards to the commander's expectation of outcomes. These relationships were developed by the author in support of SSG XIX research, based on the understanding that a decentralized and distributed network of unmanned vehicles might need to be organized differently than a more centralized logistical support structure. Based on the condition, the table identifies desired levels of unit autonomy and types of force actions that best "fit" an organizational response to the condition, and matches them to one of three organizational structures: a hierarchy, a heterarchy, or a complex adaptive system. For conditions of near certainty for example, a commander is best served by employing directive actions to achieve his intent using a hierarchical structure. An example of such a directive action is a nuclear strike in which the chain of command is authenticated and the outcome clear. Complexity has been reduced in the sense that delivering the bomb to its target is the sole military function, as it is not desirable for instance that the crew of the airplane be permitted to pick the target enroute. Command for this type of action is directive, and requires tight control over forces responsible for the actions. It is the type of action at which a hierarchy excels, but may come at the cost of initiative, creativity and self-organization.

As the outcome becomes more uncertain, however, he may rather take adaptive actions that will allow him to optimize his forces until such time that his assessment can lead his force to a more certain outcome. As noted in the table, the ideal organizational structure in this case is a hybrid structure, commonly referred to as a by complexity theorists as a heterarchy, which is a combination of a hierarchy and a network. Finally,

for those conditions that the commander may not even be aware of, a learning process must be developed if the force is to build situational awareness. While the commander can employ elements of direct supervision, standardization of outputs, and work processes, the force must also have an inherent capability for innovation. Complexity theorists such as Dr. John Holland and Russ Marion term this capacity as emergence, embedded in certain organizations, and critical to establishing capabilities for self-organization. The concepts of emergence and self-organization form the basis for a complex adaptive system, and provide the commander the necessary decentralized elements of the proposed dynamic organizational schema outlined in this thesis.

Table 3.1. Comparison of Environment to Expectation

Condition	**Desired Unit Autonomy**	**Function**	**Form**
Certainty	Minimal	Directive Action	Hierarchy
Uncertainty	Semi-automatic	Adaptive Action	Heterarchy
Equivocality/ chaotic	Full automatic	Emergent Action	Complex Adaptive System

The commander will use organizational structure as a tool to command and control military forces, and to confuse, disorient, and disrupt opponents. Shifting organizational style from hierarchical to non-hierarchical. Critical to this capability will be an understanding of these three different types of organizations, using organizational characteristics from the previous chapter.

B. ORGANIZATIONAL STRUCTURES

The following section describes organizational systems with hierarchical or non-hierarchical attributes. While there are others that may also be include, the author uses these to focus the discussion on the impact of functionality on structure.

1. Hierarchical Systems

Yaneer Bar-Yam of the New England Complexity Science Institute (NESCI) has researched control in human organizations. His research expounds on organizational characteristics, and supports the idea that decisive actions are the most predictable and easiest to direct. Such actions are easily implemented when the ranges of possible outcomes are limited and the environmental complexity has been reduced. These types of actions, while preferable from a military sense due to their simplicity, portend a complex environment of state and non-state actors.

Traditional organizational structure such as a hierarchy reflects an ordered view of the world, a somewhat linear thought process, associated by years of relatively static vs. dynamic environmental interactions. Yaneer Ban-Yam states “that in an ideal hierarchy, all communications between two workers must travel through a common manager. The problem with this is that as complexity of collective behavior increases, the manager is overwhelmed”. This type of structure serves military forces well in peacetime, providing centralized control of forces on a global scale. In network warfare, dynamic interactions better describe the environment however, and therefore other models of organization may be better suited to confront the environment. The author proposes that one method of restructuring an organization for these conditions of dynamic instability is through the application of the new sciences of complexity and chaos.

Ottaway and Bums compare attributes of hierarchical and non-hierarchical systems, quoting Hatvany (1985) as suggesting that “hierarchies are highly centralized and systems to be rigid and constrained by their formalism to follow pre-determined courses of action” (Ottaway and Bums, 2000). They identify hierarchies as desired structures during high requirements for planning. This type of organizational structure is utilized extensively today in U.S. military planning, producing long term, deliberate plans and short-term crisis action plans. The difference between the two is in the time it takes the staff to prepare them, with the deliberate production time measured in months and years, and crisis action planning measured in days and weeks.

2. Non-hierarchical Systems

For non-hierarchical systems, Yaneer Ban-Yam says that they are characterized by distributed systems, and offer advantages in speed, modularity, extensibility, scalability, reliability, and the ability to handle uncertain data and knowledge. In the context of system management, a non-hierarchical system simplifies management due to its capability for local information control and decision making. They note however that the advantages of hierarchical systems warrant the requirement to shift between the two. The non-hierarchical structure is preferred as the pace of change quickens and competition increases. Ottaway and Bums (2000) say that the hierarchical system should be utilized in areas requiring some level of planning, and "for the purposes of optimization."

In many ways, a network may be considered a non-hierarchical system, as it utilizes greater lateral connections than a pure hierarchy would. Although networks may also have vertical channels as well, Susan Mohrman from the Marshall School of Business (Cooper, 1999) argues that for organizations that utilize geographically dispersed teams, networks are lateral structures that replace the traditional, bureaucratic hierarchies. Further, she says that the lateral structures are necessary "to avoid the process losses inherent in having to deal with those issues hierarchically", since authority lies above the levels of those doing the work, and because decision responsibility is scattered across lateral boundaries.

3. Complex Adaptive Systems

While there are a number of non-hierarchical organizational structures that could be considered, this paper will discuss it in the form of a CAS. A complex adaptive system consists of independent "agents" each capable of making decisions using a few rules. It is a system of many independent agents that are interacting with each other in many forms. The very richness of these interactions allows the system as whole to undergo spontaneous self-organization. Chris Meyer, of the Ernst and Young Center for Business Innovation in Boston uses adaptive systems theory to demonstrate the relationship between the business enterprise and the economy. He gives examples of agents that are

appropriate for the context of the thesis, as agents may be people, circuit breakers, instructions (e.g. rules of engagement), or for the military context, manned and unmanned vehicles- basically any entity whose decisions can be defined by rules. The agents often behave in unpredictable ways, but since the actions of one affect the other, systematic behavior emerges. Often these emergent properties are non-linear, leading to rapid transition to a semi-organized state.

What is it that a study of complex adaptive systems offers to a military organization that is not available hierarchical systems? Primarily, it is the understanding that warfare is also a non-linear interaction that begins with the individual. In the heat of battle, forces that move in lock step with centralized control are often vulnerable to inferior dispersed forces that pick the time of the interaction. [6] The superior force is thereby paced by the inferior force, and subject to attrition losses without a compensating gain. Short of complete annihilation of the inferior force, the superior force will continue to self-deprecate. Enemy organizational properties heavily influence own force structure therefore, and must be considered when advocating a change in organizational structure. This is precisely the situation the US military is in now, as the Cold War bipolar world has been relegated to the emerging terrorist network world.

A side benefit in moving to an agent based structure is the ability to reduce bureaucracy and the size of staffs that are currently in place. In Yaneer Bar-Yam's study of human civilization, he states:

> The complexity of a system's behavior is fundamentally related to the complexity of the challenges that it can effectively overcome. At some point a collective complexity exists that overwhelms the complexity of an individual, and hierarchical structures are subsequently dominated by structures with more lateral control. The lateral actions achieve a correlation in behavior that were previously created by management. As such mechanisms are introduced, layers of management can be removed. Some of the behavior patterns that were established through the control

[6] Examples are plentiful in military history; the militia men in the US Revolutionary War, the Vietcong in the Vietnam War, and Irish Republican Army tactics against the British Army in Northern Ireland.

> hierarchy will continue to be effective, while others cannot since an increase in system complexity must come through changes in behavior. Among these changes are the coordination mechanisms themselves, which must be modified.

While some staff support is therefore still needed, the development of an agent-based force as in a complex adaptive system may be proposed as a form for a lateral coordination mechanism. In his article "Black Lights: Chaos, Complexity and Information Warfare", James Schneider, shows that this is essential, as it allows a large force to self-organize in an adaptive form, yet retain the ability to organize for direct action.

In his book "The Edge of Organization", Russ Marion characterizes a CAS by interactions among constituent parts, by homeostasis, by the ability to map their environments, and by positive feedback (Marion, 1999). He quotes a number of definitions, of which two are noted here:

> Steven Levy defines a complex system as "one whose component parts interact with sufficient intricacy that they cannot be predicted by standard linear equations; so many variables are at work in the system that its overall behavior can only be understood as an emergent consequence of the holistic sum of all the myriad behaviors buried within. Living systems epitomize complexity, so much that many scientists now see complexity as defining characteristics of life."

> Another pioneer of the study of complexity is Chris Langston of the Santa Fe Institute. He states: "A system emerges from the interactions of individual units. These units are driven by local rules, and are not globally coordinated. Small units act as adaptive actors, in large degree guided by local interests and with limited understanding of the big picture. Behaviors are based on projections of a future outcome, and thus are adaptive. Because of the dynamics of interactions between them, a system emerges. The individuals may know that they are supposed to organize, as would be the case with human systems, and in this sense it is deliberative. However, they may not remember why or how organization first occurred or why the given organizational structure is chosen over other possible forms".

This concept lays the groundwork for building the model of a dynamic organization, one that may be adapted for execution in a network warfare environment.

C. ENVIRONMENTAL RESPONSE OF ORGANIZATIONAL STRUCTURE

1. Emergent Response Properties

The extremes of network competition require that a force have the capability to survive on its own, and conduct actions that will optimize its fitness, as well as that of the entire force. For this to occur, the author proposes that the force must have a capacity for self-organization, allowing it to rapidly assess and respond to emerging threats. This proposal is supported by network-centric warfare advocates such as VADM Cebrowski of the Department of Defense Transformation Office. Steven Levy describes the emergent qualities of a CAS, saying that it resembles a living organism in the sense that it has many individual parts adapting over time to the environment they operate in.

a. Emergent Actions

Emergent actions require that the fundamental force elements are able to act independently, and they are the lowest common denominator of the command and control structure. Units of force are modeled as autonomous intelligent agents that strives to maximize local fitness, and when aggregated with the others, provides a global fitness upon which the force as a whole advances. They are highly dependent on the rule set, training, and education provided to them, and use it to compensate for the anarchical state.

Such emergent actions are desirable for an organization operating in a dynamic environment, and can assist the military commander by focusing remaining force strength. Without it, some force elements of an organization may be overwhelmed due to the large amounts of information flow, or distracted as a result of an external perturbation. When this occurs, localized elements of a force may tend towards an anarchical state. Complexity theory refers to this as a boundary known as an "Edge of Chaos" and defined as the point at which order devolves to disorder.[7]

[7] The Edge of Organization on the other hand, is the point at which order begins to emerge from chaos (Marion 1999).

This occurs without specific direction from an external source and appears to develop through a specified rule set and a learning capability. Further research by Dr. Stewart Kaufmann of the Santa Fe Institute has indicated that these adapting organizations may be affected by the presence of a catalyst that may speed up the process of self-organization (Kaufmann, 1995). He found that systems emerge as a result of dynamic autocatalytic interactions, leading to a capacity for self-organization. He has found that such organization could occur without the catalyst, but at the cost of increased time.

b. Emergent Actions Objective

The goal of the commander then, should be to recognize when the organization crosses the "Edge of Chaos", and move to encourage autocatalytic interactions amongst his force elements. The organization is assisted in crossing back over the edge of chaos by the emergent action of the agents operating in the chaotic environment, and supplemented this development by networking disparate units together to increase their situational awareness and access to resources. The role of command and control in this state is to allow the emergent properties to develop, but at the same time provide a catalyst that will speed the interactions to achieve a more pre-emptive capacity for adaptive or directive action.

2. Adaptive Response Properties

Dr. Kauffmann's research has shown that the localized emergent properties of a CAS lead it to possess adaptive, global properties, leading to his proposition of a CAS as a "primarily adaptive architecture that implements organizational forms as required for survival". As autocatalytic interactions occur, it is apparent that the organization develops. The manner and speed of the organizational development is unknown however, but is related to the number and length of the network connections. Briefly stated, with autocatalytic sets, phase transitions to ordered systems occur when a critical number of

units are linked. Dr. Kaufmann (1995) provides an excellent example of this effect when he describes a group of buttons and a group of strings.[8]

> Take a piece of string and tie two randomly selected buttons together. Select two more buttons and string them together, then two more, and so forth. Eventually, you will select a button that is already tied to another, and you will have a network of three. Later, a network of four will appear. The networks will, in all probability, remain rather small, however, until the number of draws equals approximately half the number of buttons. Then, precipitously, with the tying of just a few more buttons, a large network will emerge. You'll pick up a single button and find that perhaps 80% of the buttons are lifted with it.

Kaufmann describes this as a phase transition from small, isolated networks to a massive network, from which order has emerged.

a. Adaptive Actions

This research has phenomenal implications for organizing units in a complex and chaotic state, as is the case of network warfare. If concepts of emergence, self-organization, and phase transitions can be developed for tactical application, the adapting force of network-centric warfare can be a reality. Limitations implied by littoral warfare chaos and complexity can be dealt with in a decentralized manner, despite timing, range, and force constraints.

Emergence, self-organization, and phase transitions exist as natural phenomenon that will allow a force to capitalize the sum of its parts as greater than the whole. This is the benefit of networks as they provide greater leverage than just the individual units totaled do. Additionally, they are fully scaleable, as Metcalfe's law demonstrates. These features can be used for example, by a maritime force to seed a littoral area with small unmanned vehicles and platforms. By virtue of interactions with each other, they sense and conform to the environment, with the inevitable objective of shaping it once phase transition has occurred. The commander's goal as this is occurring is to provide the units with the catalyst, based on the experience of the force and the

[8] Source of example is Marion, 1999. For the context of this thesis, assume that the buttons represent a node and the strings a connection, or arc.

tactics to be employed. Key to this self-organization is the realization and capability of individuals to be empowered as decision-making units.

b. Adaptive Actions Objective

A Complex Adaptive System is a network of many of these agents working together towards one objective. It has many levels of organization, and can be configured to take one of many organizational forms adapting to a given situation. As such, a complex adaptive system is never in equilibrium, and instead attempts to optimize across what Russ Marion and other complexity scientists refer to as a "fitness landscape". Marion defines the landscape as an area of possible solutions that are represented by many peaks, similar to a mountain range. The complex adaptive system is therefore in a constant state of adaptation, moving from one peak, or solution, to another. The author believes that an organization configured in this manner is best suited for adapting to a situation or perturbation; rapidly adjusting its form based on the latest sensory data gathered. Such an organization offers tremendous capability to a commander overseeing a decentralized force in a dynamic environment.

3. Directive Response Properties

For a CAS to be useful as a military organization capable of military directive actions, it must have the capacity for command leadership, thereby causing an autocatalytic interaction through the force.

a. Directive Actions

A catalyst can occur in many ways, the form of which is essentially a difference in organizational theories. Two will be discussed here, Open Systems Theory and Machine Theory. [9] Machine Theory believes that controlling operating procedures increases productivity. It sets goals, delineates responsibilities, and structures authority hierarchically. Systems Theory was developed in the 1960s, and made the then-

[9] Open Systems theory and Machine theory are described by Russ Marion in "The Edge of Organization" as two historical theories of organization as they pertain to the new sciences of complexity theory.

revolutionary statement that organizational structure and behavior are heavily influenced by environmental factors more so than they are predetermined (Marion, 1999). Depending on the theory subscribed to the catalyst is subsequently determined.

(1) Machine Theory. Machine Theory seems to best describe Industrial Age processes that favor a hierarchy as it emphasizes standardization of processes. Such examples are commonly found in pre-determined outcomes, with specific measures of effectiveness and standards of quality applied. Many military processes can be used as an example of this theory today, and in most cases seem applicable to attaining stated objectives. As discussed earlier, there are a number of reasons that an organization may prefer such a hierarchical structure. For the case of a dynamic hostile environment, it seems as if the rigid structure of the hierarchy does not meet the requirement for an adaptive organization.

(2) Open Systems Theory. Open Systems Theory looks beyond the internal mechanisms of machine theory, and holds that leadership, doctrine, training, motivation and innovation are more the products of external than internal factors. Because they are subject to the influence of the environment, their impact as a catalyst is dependent on the extent to which they have adapted or rate by which they can adapt to changing conditions. If these factors are continuously adapting to the environment, the supposition is that they will be leading change rather than being bypassed by it. At the very worst, they would be able to be a “fast follower”, keeping pace with the evolutionary changes.

b. Directive Action Objective

While complexity theory is an extension of Open Systems Theory, Dr. Kaufmann has borrowed from Open Systems Theory, and has determined that perhaps the best factor to be observed is relationships. In his research, he has modeled these relationships in a network and has demonstrated that by tuning relationships, an external perturbation (e.g. a commander) can provide catalytic motivation to an organization though the relationships encouraging self-organization as environmental requirements

emerge.[10] Organizations in this realm cannot be changed according to plan or desire, nor should they be. The best that can happen is to build new connections and relationships so that a process of self-organization takes place.

D. EXPLORATION OF A CAS AS THE BASIC ORGANIZATIONAL STRUCTURE

If the CAS seems to offer the properties that a commander of a network centric organization desires, the organization may be designed with the components of a CAS as the underlying basis. Russ Marion identifies three such guiding characterizations to the extent that they contribute to the capacity for self-organization.

1. Guiding Characterizations

First and foremost the CAS must have an agent-based architecture. Secondly, it must possess a rule set for those agents to organize by, and finally, it must have an inherent propensity for emergence.

a. Agent-Based Architecture

In a CAS, an agent is a decision-making unit and may be classified as a person, a computer, or a system such as an Unmanned Combat Air Vehicle (UCAV). These agents are the fundamental unit of the adaptive organization being developed in this thesis and should have three knowledge levels as identified by Ottaway and Burns (2000). These knowledge levels are:

- Coordination knowledge to dynamically alter the structure of the system
- Operational knowledge, enabling a capability to carry out basic management responsibilities
- Interface knowledge, allowing it to interact with each other and the environment

For the system to function, these agents must be free to exercise each of these communication paths in order to interact with each other at a local level, with local

[10] Russ Marion's hypotheses are based largely upon Kaufmann's study of NK systems, or system of N actors linked K at a time. (Marion, 1999)

actions portending a greater global effect. As this occurs, decentralization can be increased without increasing associated risks of the non-hierarchical organization structure (Bar-Yam, 2000).

b. Rule Set

A CAS has a given rule set (e.g. training, doctrine, or software code) that the agents operate around. Craig Reynolds of Symbolics Computer Company developed a great example of this concept (Marion, 1999). After designing and replicating a computer-generated bird, he applied a few simple rules to each bird. Each bird was instructed to move around the screen, to avoid getting too close to any object on the screen, but not to get too far away from any other bird-like figures. What occurred upon running the simulation was a flocking behavior that allowed each figure to seek other birds, self-organize given the constraints of the rule set, and eventually fly in a formation around the screen. As the definition of a network includes the connection of disparate units using a common rule set, this demonstration provides a glimpse of the possibilities of applying that rule set across the network to build the a network-centric organization.

c. Emergence

Finally, interactions occur that lead to a third characterization of complex adaptive systems, namely the property of emergence. The environment must be conducive to allow the agents the opportunity to interact, after which they can apply their agent-like qualities per a given rule set to achieve the desired levels of self-organization. Using the example above, the flocking birds were able to be modeled as an agent, operated according to the specified rules, and organized as they came into contact with other units. They did this in the environment of the computer screen, which was defined in scope. Without such a defined environment, it may be possible that they never would have interacted, and the desired level of self-organization not achieved. Dr. John Holland says this another way when he identifies one recurring theme that is essential to emergence: in each case there is a procedure for freely generating possibilities, coupled to a set of constraints that limit those possibilities (Holland, 1998).

2. Edge of Organization

Together these three elements comprise the manner in which a CAS is able to self-organize. The commander must understand this relationship, and know that for the CAS to be effective as a military organization, these characterizations must be established. As this occurs, his expectations of self-organization will be measured by how close they lie to what Russ Marion's "Edge of Organization."

E. OPERATIONS IN THE CAS

The objective of the network-centric organization is to place more decision-making capability with the front line warfighter. A network-centric technostructure can enable the organization by producing a flatter organization, reducing levels of vertical command levels, and thereby realizing an increase in speed of command.[11] It substitutes vertical levels with multiple horizontal connections and provides three types of knowledge to the users in the organization. Substituting horizontal connections for vertical ones does not necessarily imply an increase in speed of command by itself, however. Factors such as the manner in which the connections are made, the nodal elements themselves, and the number of connections to each node may all have an influence. While further study needs to be done in this area, the network diagram promoted by complexity theorists does demonstrate an increase in speed when the network connections are structured along a "small world" network (Marion, 1999).

1. Small World Networks

A small world network is one that lies between a maximally connected network (all nodes connected to each other) and a minimally connected network (each node connected to one other). The small world network shown in Figure 3.1 is of interest in this thesis's proposition for a network-centric organization in that it minimizes communication path, and therefore associated delay, compared to the maximally or

[11] This is the subject of ongoing discussion and experimentation, but offers great promise if it can be incorporated as part of the network-centric organization. In their book "Network Centric Warfare", Alberts, Garstka, and Stein outline how this may be the case.

minimally connected network. In other words, it allows the reader to assume that the commander will have the ability to either horizontally or vertically connect his organization through the technostructure so as to minimize communication path delay. This considers only the number of paths, and does not imply any assumptions regarding reliability, fidelity or other measures.

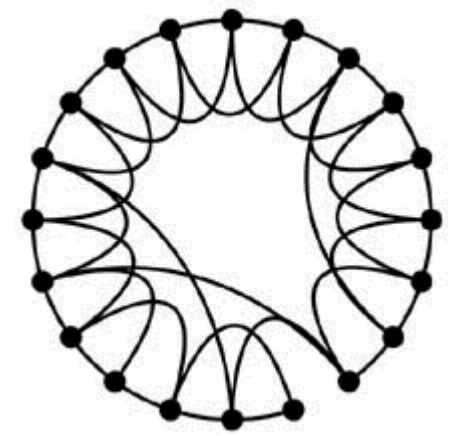

Figure 3.1. Small World Network. [12]

The elements of a complex adaptive system discussed so far: agents, rule sets and emergence, connected through a small world network, are properties required for self-organization. The environment that this self-organization develops in, and which is common to a complex adaptive system, is the order that lies on the Edge of Organization. This effect is identified by many complexity scientists, and is evident in Kaufmann's NK model and button example. It is this effect that provides potential for a commander to reorganize structure on the fly by tuning levels of interactions and defining the environmental constraints.

[12] This graph was accessed 10 January 2003 at:
http://www.santafe.edu/sfi/publications/Bulletins/bulletinFall99/workInProgress/smallWorld.html

2. Adaptation at the Edge of Organization

Essentially the edge of organization is a point of inflection at which a system teeters on the edge of organization and chaos as seen in Figure 3.2.[13] Here, complexity theory holds that an organization is in its most adaptable state. Organizations operating near chaos are in the most active and creative state, as agents are actively struggling to maintain order, using all sensory elements to tip their state from chaos to order. It is also here that the concept of a phase transition applies, for as more and more agents move away from chaos, an exponential chaos to order occurs. For a military force, the author proposes that this may equate to increased combat power resulting from an organizational configuration action on the part of the agents (emergent action), the force (adaptive action) or the commander (directive action). The role of the commander in such an organization is to keep the agents focused, and prevent them from entering a state of chaos. The commander defines the rules in an organization, and his challenge is to establish a culture strong enough to allow innovation to flourish, leading to greater capacity for self-organization. The speeds at which the commander can change the rule set, and impart that change throughout the organization, will then directly impact the speed at which a force can tailor actions to respond to the dynamic environment. If the force does break down into a chaotic state, the commander, through relaxation of coordination knowledge and an increase of interface knowledge, can initially release agents on a limited basis. As order begins to emerge in the system, the commander can look at linking significant agents together; creating a small world network that does not overburden the larger network. He can also begin to leverage the system as it comes together, moving in stages from emergent to adaptive to decisive action.

[13] Figure 3.2 depicts a functionality curve for the different organizational types over a range of complexity (low to high), and a domain of order (order to chaos). It graphically portrays the shifting organizational structures that are required for the varying environments that a network-centric organization may have to operate in.

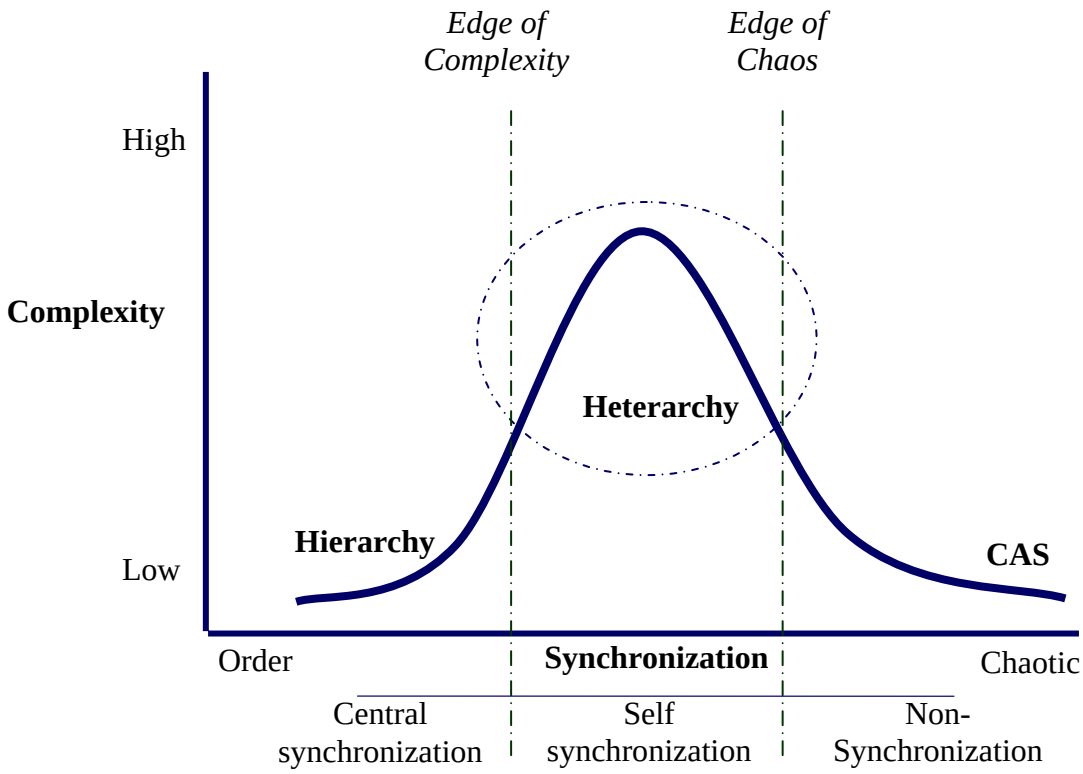

Figure 3.2. Functionality Curve for Different Organizational Types.

F. HETERARCHY AS THE ORGANIZATIONAL STRUCTURE FOR NETWORK-CENTRIC MILITARY FORCES

A hybrid organizational structure that capitalizes on the stability of a hierarchy and the dynamic adjustment of the CAS seems to be the best structure for a dynamic environment. This thesis proposes that a hybrid organizational structure such as a heterarchy may best meet the organizational requirements of the network-centric organization. Control of forces in a heterarchy is loosely coupled, and the commander relies on trust, awareness, and teamwork to accomplish objectives. This type of force acts effectively across all organizational boundaries (vertical, horizontal, geographical and external) as identified by Ron Ashkenas in his concept of a boundaryless organization (Ashkenas, 1995). It is here that interoperability becomes more important to the force, as it can then leverage opportunities not previously considered under a hierarchical organization.

1. Description of the Heterarchy

The heterarchy combines elements of a hierarchical structure with a CAS, and it is optimized at the peak of complexity by allowing adaptive action to prevail. It maintains the discipline of a hierarchy, the flexibility of a network, and excels in all dimensions of the hyper-competitive landscape by associating action type to environmental conditions. Directive action is available through the commander's tangible or intangible intervention. The structure acts naturally as a complex adaptive system by applying simple local rules and connections to achieve emergent global behavior. When combined, the distributed network aspects offer advantages in speed, scalability and reliability that allow the force to be highly adaptive, and less exposed to a catastrophic failure of a single nodal element. Rules and connections are directed horizontally and vertically, and information is passed quickly to eliminate non-value adding and resource intensive activities.

2. Attributes of the Heterarchy

Ottaway and Bums best summarize the desired system behavior where they identify attributes for adaptive organizational architectures as a heterarchical mix between the hierarchy and the non-hierarchical systems. Specifically, their desired system behavior is as follows:

- The preferred structure of the system should be non-hierarchical
- The system should be capable of introducing hierarchy as necessary to facilitate planning and optimization
- The system should be capable of introducing hierarchy as a function of the time horizon of the planning
- The system should be capable of localizing the hierarchy to only that portion of the system that contains the knowledge necessary to facilitate the planning activity or that is affected by the planning activity.
- The system should be capable of returning those portions of the system to a non-hierarchical structure when their respective planning activities have concluded.

These characteristics emphasize the need for both hierarchical and non-hierarchical attributes for an adaptive organization. SSG XIX research has indicated that these characteristics may similarly best fit the network-centric organization that envisions a large number of software agents, platforms, sensors, weapons, and warfighters (SSG XIX Report, 2000). The heterarchical organization provides the commander the flexibility to command and control his forces using hierarchical or network controls, or combination thereof. It also allows his force to do the same.

G. DYNAMIC ORGANIZATIONAL SCHEMA

Low complexity and order situations allow the commander to utilize a hierarchical organizational structure, and may be indicative of situations familiar to the commander and his force (e.g. routine tasks). As complexity increases, the commander may use the hierarchy up to a point where he crosses an edge of complexity, identified in the positive slope, non-linear region on the curve. The author defines this edge of complexity as the point where command and control of organizational tasks rapidly exceed hierarchical control. At that point a heterarchical structure is best suited, and allows for adaptive action, combining the elements of the hierarchy and a network.

1. Functional Transition in a Heterarchy

The heterarchy is the area where self-synchronization occurs easiest, and provides greater speed and resilience due to its adaptive nature. As the complexity in an environment increases, order tends to devolve towards chaos, and at some point an edge of complexity is passed and decisive actions are not as effective, or require tremendous resources to ensure effective command and control. Adaptive actions are better suited for this environment, and the commander of a network-centric organization should tune his structure to foster heterarchical attributes. Due to the perverse nature of hyper-competition, even a heterarchy can begin to break down (possibly due to a parallel assault on the leadership and the network) and thus order devolves toward chaos. Once again, an edge of chaos is crossed as the region becomes non-linear and structure breaks down into anarchy. It is at this point that the commander relies on the emergent action of his force,

while simultaneously providing a catalyst to move the organization back along the curve (For example, a hierarchical C2 application could provide the impetus to organize forces in an anarchical situation).

2. Attributes of the Dynamic Organizational Schema

Each organizational structure has particular attributes associated with it that are illustrated in Table 3.2. The vertical axis identifies the attribute, and the horizontal axis identifies the aspect of that attribute particular to the structure. There are obviously many more attributes that could be applied, but these five are particularly applicable to organizational design and have been chosen to illustrate the concept.

Table 3.2. Organizational Attributes

	Hierarchy	**Heterarchy**	**CAS**
Organizational emphasis	Platform Centric	Network Centric	Agent Centric
Organizational synchronization	Central Synchronization	Self-synchronization	Non synchronized
C4I Systems	Closed	Interoperable	Open
Network connections	Minimal	Small World	Maximal
Action Type	Directive	Adaptive	Emergent

The table illustrates the different qualities of network-centric warfare that are associated with each of the three organizational structures discussed in this chapter. It also illustrates that each structure is associated with certain characteristics that a commander may find desirable for his forces, depending on the operational environment he is in at the time. As said earlier, the Commander must be familiar with how these attributes stack up under given structures, and he can then pick and choose amongst them to best tailor his organization for a given scenario. Depending on the commander's intuition and intent, he will be able to build his own curve to control the boundaries

between the edges of complexity and chaos. His ability to tune the organizational schema is determined by the interactions he allows between his agents, as much as by the extent they simultaneously seek to build these interactions through their own new exploratory relationships.

H. SUMMARY

In the military, the pairing of authority and responsibility to decision making is used to compensate risk. Decision making authority is delegated throughout the chain of command, but responsibility is not. A control system must therefore exist that can assure that military forces are held accountable for their actions. Currently the one in place is the hierarchical chain of command. While the hierarchy has demonstrated sustainability however, it may not be the optimal structure for a network warfare environment. A new control system therefore must emerge that would provide a relationship between authority and decision-making that balances them in the context of ecological fitness.

Recent research into social network theory has identified agent-based models that may allow this to occur. These agents, while capable of functioning on their own, also draw synergistic effects by integrating themselves into higher level organizational structures. They will enable the commander to move forces forward into network warfare with full confidence in their ability to dynamically reorganize. A Complex Adaptive System based on intelligent agents is constantly revising and rearranging their elements as they gain experience. The system is never in equilibrium, but rather always unfolding and in transition. It is this type of system that is envisioned as a future organizational architecture for the network-centric organization.

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IV. JOINT COMMAND AND CONTROL STRUCTURES FOR MILITARY FORCES

The network centric organizational architecture has been developed to this point in regards to its characteristics and form. This chapter will discuss one of the functions for which it must operate, emphasizing the planning and collaboration requirements for the combatant commander's staff. It includes a brief discussion on the US military's planning guidance and assumes that they will not change significantly as the organization transforms from a platform-centric to a network-centric force. This is necessary to frame the integration boundaries that will be required for the dynamic organizational schema.

A. JOINT PLANNING

Three levels of warfare are delineated in Joint Publication 3-0 (JP 3-0, 1995) as strategic, operational, and tactical. At the top is the strategic level, generally accepted to be at the Combatant Commander (COCOM) and above. The Operational level command usually takes the form of a hierarchical Joint Task Force (JTF) that can be led by a number of different elements. The primary purpose of command at this level is to integrate joint or service forces to plan and execute specific tasking. The JTF has command and control over the third level forces, those at the tactical level, therefore any proposed transformation of the COCOM organization will impact tactical level organizational structures and informational systems as well.

The Combatant Commander delineates the operational level tasking through a mission statement to the operational commanders. The mission statement is the result of a comprehensive mission analysis based on either a deliberate or crisis planning scenario. The guidance for producing the mission statement derives from a number of documents, as well as consultation with the President of the United States (POTUS) through the Secretary of Defense (SecDef) and Chairman of the Joint Chiefs of Staff (CJCS). An organizational structure for a Joint Task Force must then be able to build capability into both a deliberate and crisis action planning cycle.

1. Deliberate Planning

Forces are geographically located with respect to their ability to flow into a theater of operations within set time windows. This force flow is established in the deliberate planning cycle, with the goal of optimizing available airlift and sealift, host nation support, and the force's organic abilities. Due to these variables, a crisis action plan must often be subject to forces available under the deliberate plan's force flow schedule. These planning requirements and limitations are one of the many factors that drive organizational and informational systems development.

The U.S. military force structure is currently geographically based and organized according to the deliberate plans that protect vital U.S. national security interests. There are four principle documents that outline these interests and planning requirements to the Combatant Commander. These documents are promulgated by a number of sources, but derive their overriding guidance from the three branches of the U.S. government. The documents are the National Security Strategy (NSS) [14], the National Military Strategy (NMS) [15], the Joint Services Capabilities Plan (JSCP) [16], and the Quadrennial Defense

[14] The Office of the President produces the National Security Strategy. It is the principal document that outlines the nation's interests, classifying them as Vital (Tier I), Important (Tier II), or Of Lesser Importance (Tier III). The NSS also outlines a general security strategy that evolves with each change of the administration, yet keeps the principles of a democratic government as its core. Currently, the NSS under President Bush calls for a strategy of "Security Cooperation" and it provides the overriding principles of security about which the nation's interests depend on (NSS, 2001).

[15] The National Military Strategy is the U.S. military's interpretation of the NSS, and highlights the elements of the NSS that are of particular relevance to the military forces. The NMS is published by the Secretary of Defense on an as needed basis to ensure that it is aligned with the NSS. The current NMS in place is dated September 30, 1997, and was therefore published under the Clinton administration. There is a new one due out shortly, which should redirect military efforts from engagement and enlargement to the security cooperation agenda (NMS, 1997).

[16] The JSCP is the document that directly drives the Combatant Commanders to develop deliberate plans for specific tasks required achieving the national interests. While these plans are principally concerned with military plans, the tasks they require can often be accomplished through other avenues of approach other than just military force. The COCOM and his also staff have Diplomatic, Informational, Military, and Economic (DIME) options. These ensure that a combatant commander looks at all elements that can be used to accomplish his task as outlined by the JSCP, as well as coordinates these plans among the various services capabilities. The COCOM may also elect to include national agencies also to fully utilize the DIME concept (Joint Staff Officer's Guide).

Review (QDR) [17]. Table 4.1 highlights each of these documents, their source, their intentions, and their relationship to each other.

Table 4.1. National Planning Guidance

	Source	**Purpose**	**Intentions**	**Relationship**
NSS	POTUS	Overall security strategy	Outlines global security priorities	Top level values
NMS	SecDef	Overall military support to NSS	Outlines military support to NSS	Developed from NSS
JSCP	CJCS	Allocates resources and tasks to COCOM	Provides planning guidance to COCOM	Yearly cycle review to support NMS
QDR	Congress	Examines force structure resources	Similar to JSCP	4 yr. review of overall force size

The military is tasked by these documents with ensuring the nation's security interests are protected, using force if necessary. The COCOM takes the guidance from these documents, aggregates their intention, and produces the plans necessary to accomplish the tasks. Primarily, these take the form of a "deliberate" plan, one that involves a detailed planning process by members of his staff, and is eventually submitted to the SecDef for approval. The planning cycle for a deliberate plan is generally 18-24 months, and resulting in an Operational Plan (OPLAN), Conceptual Plan (CONPLAN) or Functional Plan (FUNCPLAN). The OPLAN is prepared for situations that are sufficiently critical to national security that detailed planning is required. The CONPLAN is for a contingency not sufficiently critical to national security to require detailed planning, and the FUNCPLAN is a plan prepared for anticipated military operations other than war or non-hostile environment.

[17] The QDR is published once every four years, with the goal of examining the current force structure and anticipating where resources need to be developed or deleted. The QDR is similar to the NMS in that it outlines the military's requirements, and aligns the deliberate planning cycle to the force structure required to execute the plan (Joint Staff Officer's Guide, 2000).

The secretaries of the military departments are responsible for the efficiency and preparedness of the Services, and for developing supporting operational guidance. The component commanders of a JTF therefore have both an operational and service, or functional, chain of command. In essence, the component commanders support the operational needs of the COCOM to the extent they are supported by their service. Joint doctrine (Joint Staff Officer's Guide, 2000.) holds that the organizational structure that the operational component commander organizes his forces under therefore has tremendous relevance to their capabilities under the Combatant Commander.

2. Crisis Action Planning

Crisis Action Planning has a much shorter cycle time that deliberate planning. Generally, the requirement for CAP means that the COCOM has from a few days to a few weeks to put together a plan for CJCS approval. The organizational structure utilized for crisis planning is the same as the deliberate planning; but the fidelity of the plan usually is not. In the best case, a COCOM has a standing OPLAN or CONPLAN that resembles the actions required by the crisis. In the worst case, the crisis is completely unique. An example of the former would be a standing plan for a Non-combatant Evacuation Operation (NEO) that could be applied to any country. An example of the latter might be a crisis that requires an operation against a country previously viewed as a neutral or an ally.

What is the relationship between the action types that were discussed in the previous chapter and crisis action planning? Generally speaking, hierarchies are very effective at direct action, and deliberate planning. A heterarchy is designed for adaptive action, and adaptive planning. Economic sociologist David Stark defines a heterarchy as an organization which operates with minimal hierarchy and which has organizational heterogeneity. [18] To prosper in such a situation, Stark believes management becomes the

[18] http://www.santafe.edu/sfi/publications/Bulletins/bulletinFall99/features/organizationDiversity.html accessed 7 Mar 03.

art of facilitating organizations that can perpetually reorganize themselves. “The solution is to minimize hierarchy,” he says. “Authority is no longer delegated vertically, but emerges laterally.”

A CAS performs well when emergent action is needed, but it has no organic planning capability. Using these descriptions, crisis action planning would seem to be best fit to a heterarchy, as it maintains some of the capabilities for deliberate planning due to its hierarchical element, but also capitalizes on the continuous emergent performance of the CAS. The two elements together then operate to develop information leading to a crisis action planning capability that is essential to combating a networked but decentralized for such as a non-state or terrorist network.

3. Current US Military Operations and Guidance

Secretary of Defense Donald Rumsfield envisions that the US military will be faced with more requirements for crisis action planning than ever before. This is primarily due to terrorism by non-state actors, for which deliberate plans have been limited in their applicability. His guidance to military commanders has been to transform the military organizations to be ready to rapidly respond to contingencies worldwide that are limited in scope and duration. Operation ENDURING FREEDOM is and ongoing operation in Afghanistan that demonstrates this requirement as it is a plan that was rapidly directed as a response to the terrorist attacks of September 11, 2001. This operation involved all services of the US military as well as coalition forces, and was designed to counter terrorist forces operating in Afghanistan. This operation, while not considered as a deliberate planning requirement pre 9/11, was quickly implemented as both a reaction to the attacks and as a preemption against future attacks.

4. Service Responsibilities

Earlier in the thesis, organizational structure was dissected into its essential components, and these were further shown to produce design parameters for an organization that could be used to tailor a structure to a purpose. The national level documents state the purpose for which the services must organize to align forces with the

tasks assigned by the COCOM during deliberate and crisis action planning. The organization must meet also the tasks set by the service secretary. Building an organization that can do these tasks, mapping it to a corresponding joint force C2 capability, while still accomplishing service specific requirements, is one of the challenges that the net-centric organization must meet.

The next section will outline how these objectives are accomplished using current Joint C2 structures both in use and in experimentation, and discuss their relationship to organizational design parameters, and their advantages and limitations to accomplishing the goals set forth in the NSS.

5. Joint Operation Planning and Execution System

The Joint Operation Planning and Execution System (JOPES) is the integrated joint conventional and nuclear command and control system used to support military operation planning, execution, and monitoring activities. JOPES is outlined in the Joint Staff Officer's Guide, and outline the two different types of planning cycles required of the Combatant Commander. Direction to initiate one of these cycles is the receipt of a strategic or operational mission/task. During the deliberate planning process of JOPES, the strategic task is delineated from the Joint Strategic Capabilities Plan; during crisis action, the task originates as a Warning Order or as an Execute Order from the CJCS. Once this task has been accepted, the next step in the process is to develop Situational Awareness (SA) via a mission analysis of friendly and enemy forces, tasks assigned, and the timeline required.

B. JOINT FORCE ORGANIZATIONS

The Goldwater-Nichols Act of 1986 directs the application of Joint Force Organizations for all major US military conflicts. It was developed to leverage the capabilities of the services, and to delineate the command and control of joint operations. A joint publication system was also developed to provide historical and doctrinal examples of joint force organizations. Primarily, this has centered on the use of a Joint Task Force, or for coalition organizations, a Combined Joint Task Force.

1. Joint Task Force

The Combatant Commander establishes the command relationships during the planning cycle. As the mission analysis is developed, a concept of operations is formulated and eventually the COCOM formalizes selected Course of Action (COA). A given COA must then be associated with a concept of deployment and a concept of support. Once these have been established, the point of execution has arrived. As the operation unfolds, the joint commander ensures that situational awareness continues to be updated, and forces are applied over the correct dimensions of space and time to ensure mission accomplishment.

The selected COA will outline the coalition C2 relationships, as well as the U.S. force C2 structure. For U.S. command relationships, there are six options available for the COCOM to choose from: subordinate unified, a JTF, functional component, service component, single-service force, or specific operational forces. The most likely choice for a joint crisis operation such as Operation ENDURING FREEDOM (OEF) in Afghanistan would be for an integrated joint force since there would be elements of each service involved. Of the six available, there are three structures that best meet this requirement. A subordinate unified command could be established to conduct operations on a continuing basis, or a Joint Task Force could be selected to conduct a mission with a specific limited objective and does not require overall centralized control of logistics.

The third possibility is one that may be employed due to the mission assigned and the urgency of the mission. The specific operational force structure meets these criteria, and was in fact the C2 structure in place at the beginning of Operation ENDURING FREEDOM. While there were obviously many peripheral reasons for this choice, the overriding factor was most likely due to the rapid escalation of the global war on terrorism following September 11th, 2001. The national level of attention, coupled with the urgency of conducting a counter-attack against the Al-Queda center of gravity (freedom of maneuver in Afghanistan) necessitated the close command of operational forces.

2. Standing Joint Force Headquarters

The operation in Afghanistan involved both joint and combined forces, operating from a crisis action-planning situation. With only this task, the reader may assume that the COCOM chose from a number of different C2 structures as outlined in Joint Pub 3-0, using a JTF or sub-unified command, as well as a separate coalition structure. There is one other possibility however, a structure known as the Standing Joint Force Headquarters (SJFHQ) currently under experimentation at the Joint Forces Command (JFCOM).

Joint Forces Command has explored the alternate command structure known as the SJFHQ in order to develop an adaptive command and control structure, established in peacetime, and designed to manage information and plan for contingencies in advance of crises, and when directed, command joint forces.[19] The objective of maintaining a SJFHQ is to significantly improve the readiness by providing for continuous contingency planning, and an ability to rapidly establish a Joint Task Force Headquarters. It accomplishes this objective by organizing as a team of operational planners and information command and control specialists.

a. SJFHQ Fundamental Concepts

The SJFHQ introduces three concepts as critical to 21st century military operations. First, is the continuously updated Operational Net Assessment (ONA). This is a support tool that provides a JTF Commander visibility of effects-to-task linkages based ONA system of systems analysis of an adversary. This ONA is used by the Commander to conduct Effects Based Operations (EBO), which is designed to target those enemy linkages that will affect the enemy's behavior. It utilizes all elements of national power, coordinated through the third element of the SJFHQ, a Joint Interagency Working Group (JIACG).

[19] www.jfcom.mil accessed 20 Feb 03

b. Knowledge Building Through Reachback

The operational concept of the SJFHQ entails the use of collaborative tools to build an extensive knowledge base of focus areas that can be used in the planning process. The knowledge base is built by linking regional and planning experts through the use of "reach-back" to pull specialized knowledge into the planning process. It is an adaptive command and control architecture in the sense that it can quickly assimilate data through the entire planning process, from mission analysis to execution. As a result, C2 information can be better adapted to a commander's situation and crisis action plans can be made and carried out more rapidly and effectively.

The reach back element is especially important in current military operations as media coverage and information operations have greatly increased the linkage and coverage of military operations to their diplomatic origins. The SJFHQ uses the JIACG to ensure that the JTF's Information Operations campaign continually targets the enemy's forces, whether directly through attack operations or indirectly through media sources. Reach back is also critical to the C2 structure in that it provides immediate feedback to the commander on the effect the planning has had on interagency and coalition interests, as well as the effect the operations are having on the enemy. As these data points are directed back to the commander, it in turn is assimilated into the ongoing ONA, from which operations are then adjusted.

c. SJFHQ Heterarchical Attributes

For the purpose of the proposed dynamic organizational schema, the SJFHQ most closely resembles a heterarchy as a military organization, and will be used to contrast the traditional JTF hierarchy through the rest of this thesis.

Considering the SJFHQ as a heterarchy, it is interesting to observe that it employs the critical elements for success in the network warfare environment as outlined in the preceding chapters and the JFCOM website.[20] It does this in the crisis action planning process by providing the Commander the ability to:

[20] www.jfcom.mil accessed 20 Feb 03

1. Maintain a continuous initial position through an Ongoing Net Assessment
2. Rapidly seize the initiative and achieve short-term advantages by leveraging interagency coordination and reachback, obtaining information rapidly from forward-deployed forces.
3. Achieve long term objectives through effects based operations.

C. PLANNING RELATIONSHIPS TO ORGANIZATIONAL STRUCTURE

Up to this point, the building blocks of any organization have been identified using Mintzberg's theories. Three organizational structures were then discussed as they related to the types of actions it is envisioned that a Joint Force Commander will have to be responsible for in a network warfare environment. The three action types (directive, adaptive, and emergent) were mapped to three organizational structures (hierarchy, heterarchy, CAS) that were particularly adept at facilitating that type of action. Finally, the hypothesis that a Commander may need to have an organization that could rapidly shift structure according to action types was postulated as a requirement for a dynamic organizational schema.

Specifically, this dynamic organizational schema was provided as the outline for the net-centric organization, and this capability was identified as it applied to the planning function of a Joint Force. The expectation is that a force cannot be considered capable of achieving directive, adaptive, and emergent tasking if its command and control component was not similarly configured, and one of the essential tasks of that structure involved planning. The planning function was also used as an example due to the increasing requirement for crisis action planning in a unilateral world, and the benefits that a dynamic organizational structure could bring to a Joint Force Commander operating in this environment.

1. JTF (Hierarchy) vs. SJTF (Heterarchy)

Now, the application of Mintzberg's design parameters will be used to identify which structure, the traditional JTF hierarchical structure or the proposed SJFHQ heterarchical structure, is the one best able to operate as a dynamic structure. The net-

centric organization must then be developed along these lines so as to produce a capability at the operator's level that meets the intent of the Command level.

Table 4.2 provides an overview of Mintzberg's organizational structural attributes and design parameters as they might relate to a notional JTF and SJFHQ structure. The six parts of the organizational structure outline the manner in which a traditional JTF functions as a hierarchy, and the manner in which a SJFHQ utilizes greater advantages of networks to incorporate reachback and feed forward information flow. The design parameters similarly highlight the advantages of the network to match dispersed forces against each other. Roughly, the correlation shows that the SJFHQ is a more adaptive structure, one that moves away from rigid command and control structures in place of a more sensing architecture. This type of architecture allows for greater mutual adjustment through standardization of outputs, skills, and norms.

Table 4.2. Relationship of a JTF and SJFHQ to Organizational Attributes [21]

JTF (Hierarchy)	**Continuum**	**SJFHQ (Heterarchy)**
	Organization Structure	
Efficient system for making decisions on deliberate plans	***Operating Core***	Adaptive system for responding to rapidly changing threat axis
Commander's Intent	***Strategic Apex***	Commander's guidance
Commanders Staff Functionally managed, centralized planning. Cascade orders down COC.	***Middle Line*** / ***Technostructure***	Staff, national agencies, multi-national feeds Create a unified view of the environment and key processes. Customized planning.
Single representative; geographically located	***Support Staff***	Full reach-back to multi-evel expertise.
Strategy as a plan. Threat based.	***Ideology***	Strategy as an adaptive design to respond faster. Capabilities based.
	Design Parameters	
Enemy geographically identified. Staff co-ocated with CDR.	***Distribution & Dispersal***	Enemy dispersed. Staff dispersed.
Tight coordination	***Decentralization vs. Centralization***	Loose coordination
Functional	***Grouping***	Market
Limited	***Unit Size***	Un-limited

2. Organizational Structure and Design Parameters of the SJFHQ

Standardization of outputs is greatly enhanced in the SJFHQ structure as the output is clearly identified through development. Increased use of reach-back and data mining will serve to enhance the battle staff's operational picture, and contribute to the development of a common operational picture.

[21] The format for table 4.2 is outlined by Haeckel in his book "Adaptive Enterprise". The data in the table is the author's interpretation of the JTF and the SJFHQ as they might relate to Mintzberg's structural characteristics and design parameters.

a. Standardization of Skills

As standardization of skills increase, collaboration increases. Collaboration can in turn lead to a higher level of trust among the staff members participating. Dr. Uri Merry is one of the primary theorists for the practical application of complexity theory to social systems. He has written a number of articles including one of great applicability to this discussion. *In Practically Applying the New Sciences to Organizations*, he says that "trust is essential to building up mutual coordination" (Merry, 2000). He believes that trust is actually a design principle for collaboration, for without it the tendency to maintain human or system reliance on the hierarchical command and control structure will continue. He believes that the more trust can be built into an organization at all levels, the less that organization has to rely on tight procedural, structural, hierarchic, command and control forms of coordination and control.

E-Bay is a great example of a market definition of decentralized command and control, where the commander (E-Bay) facilitates transactions through collaboration across a common medium. Trust is built into the organization through a feedback loop where people rate the buyer and seller for their reliability. While this exact method is not a system a commander would utilize the principles of standardization of output is essential to collaboration and involves both trust and technology. Use of the E-Bay model is a point from which to deviate, and with a similar application to a SJFHQ, a commander could move decision making to market conditions wherein the collective collaboration cells promote information rather than responding to a task.

b. Standardization of Norms

Standardization of norms ties directly into trust, as a collaboration cell is more likely to trust each other given a greater homogeneous mix of their components. A group of naval aviators collaborating together would have an edge here than perhaps a multinational group with differing agendas. Or maybe not…and this dilemma is one that a commander must be aware of. The interaction level may be a measure to which the commander can be assured of a cooperative collaboration environment, and therefore his assurance level is increased.

D. COMMAND AND CONTROL IN THE NETWORK-CENTRIC ORGANIZATION

In his book “Adaptive Enterprise”, Stephen Haeckel (Haeckel, 1999) discusses the movement of an organization from a hierarchical structure to an adaptive, heterarchical form. He believes, first of all, that the future organizational structure must change to respond to faster changes in the competitive markets. The key to moving along the continuum from a hierarchy that produces functional tasks to what he calls a “sense and respond” organization, is to develop a new type of governance. His ideas are consistent with the calls that military leaders today are requesting in their transformation efforts, and also what the SJFHQ is designed to accomplish. His method of transforming hierarchical structures to a heterarchical structure is to develop the organization along constructs of context and coordination.

1. CAS Command and Control Limitations

Interestingly enough, Haeckel recognizes the capabilities that the Complex Adaptive System Theory can add to transforming staid organizations to a sense and respond structure. He points out that the tenets of emergence and empowerment through simple rule sets leading to self-organization are fundamental elements that, in and of themselves, are unsatisfactory for running large, complex organizations common in the business world. Companies that have tried to divest themselves of traditional control structures have found that empowerment and self-organization do not accomplish the primary objective of the company, to turn a profit. In many cases, he has observed senior executives commenting on what resulted were “lack of accountability, too many visions, lack of synergy, poor execution”. Divestiture of governance in these cases is not what this thesis advocates, rather it makes the point that the dynamic organizational schema must operate at a heterarchical level, relying on the built in capabilities of the CAS model to assure that the organization is always functioning at some level.

A network-centric organization built on a CAS backbone must have a control system for the military to use it effectively as a command and control structure. The SJFHQ for instance, does not operate as a CAS. It operates as an organizational entity

that emulates a CAS in certain conditions, but provides for direct input from the commander when necessary. He does this by his management of the interactions between the nodes in the system.

2. Context and Coordination

Haeckel terms this type of system governance as "Context and Coordination." The leader of the organization provides the unambiguous context, and then develops a system of coordination to govern its accomplishment. Although similar to traditional command and control, the author believes that context and coordination places greater emphasis on adaptive actions over directive actions.

a. Context

Organizational Context encompasses three parts: the organization's reason for being, its governing principles, and its high level design. In order for a SJFHQ to produce an implementable Course of Action, it must meet certain criteria that the Commander must outline at some point prior to the execution. In a JTF structure, the mission statement had to be completed prior to the development of a COA. Unfortunately, by the time the mission statement had been developed, the situation may have changed to the point where an assumption or risk outlined in the analysis may no longer be valid. It must be assumed for a rapidly changing environment therefore, that sequential Crisis Action Planning will not be acceptable. By providing a context instead, the Commander moves from issuance of a mission statement, to issuing a "reason for being" statement which clearly defines the organization's primary purpose. By doing this, the author proposes that he place greater decision-making capability at the point of action vs. the point of governance. He can do this prior to any crisis developing, and the Operational Net Assessment ongoing in the SJFHQ will use it to guide their assessment. The commander can also issue the restraints (an action that cannot be accomplished) and constraints (an action that must be accomplished) to guide the staff as part of his governing principles. These are made available to the collaborative C2 cells and are incorporated into the process of building the ONA. Finally, the last element of Context is

for the commander to illustrate the relationships both inside and outside the organization in terms of what each group owes each other. These will be crucial for the commander of a net-centric organization, as Moore's Law indicates that the power of the network is a function of the square of the nodes.

Haeckel (1999) sees Context as "three components that tell accountable, empowered people where the organization is headed, the boundaries on their actions, and a picture of how and what they do relates to what others do and to organizational purposes." It provides an unambiguous framework for aligning individual activities to organizational behavior in a rapidly developing world.

b. Coordination

Context is the strategic direction for an adaptive organization, but it is only one half of the governance required. Coordination is the other essential element that must be monitored and tweaked to ensure that the group is tracking along the lines of the context. Remember that the goal of the heterarchical structure is not to let a system exist solely as a complex adaptive system. Rather, this thesis has proposed that it is to provide a catalyst when able to expedite the responsive nature of a CAS to achieve results on a faster basis. Coordination elements as described by Haeckel are designed to ensure that the organizational context is transcribed into actions that accomplish the context. He states that "the goal in an adaptive organization using coordination is to define the consequences of their actions as superior to the action itself" (Haeckel, 1999). The goal of the commander is to coordinate the interactions of the people in the organization. In a sense, it is effects based operations in reverse, managing and building organic links to strengthen the decision-making capability of the group through greater access to information. For the SJFHQ, this can be a rather large group, depending to the extent at which reach-back is implemented. If the goal of the context was to position the obligations of the nodes in the network, the goal of coordination is to ensure that each node has best access to other elements that can help it achieve its individual objectives. As the situation changes, the ongoing Operational Net Assessment must continue to develop by connecting to other nodes as necessary.

3. Planning Relationships

Context and Coordination provide the ability for an organization to become adaptive to its environment. They can increase organizational mutual adjustment to the extent that the nodes in the organization understand the big picture, and can connect to other nodes when necessary. In this structure, the concepts of dispersal and distribution are inherent, as the organization does not rely on direct top down guidance to develop its architecture. Rather, it thrives by having a general construct to work in and then leveraging that construct among other nodes to sense and respond.

The respond aspect takes the form of a decision in the crisis action planning cycle that has been used as an example. In the traditional hierarchical planning structure, the commander prepares a mission analysis, promulgates a mission statement, and then asks the staff to develop a number of Course of Actions. Once again, this is a sequential process that is not very responsive. The chosen COA represents the decision of the commander, and must be authored to the point where it is nearly predicting the future, a near impossibility. As Murphy once said, “no plan survives first contact with the enemy”. The commander needs the capability in the networked world to rapidly achieve initial response, continue the assessment throughout the campaign, and rapidly adjust forces to counteract the moves of the enemy. There is no way in a rapidly changing world to anticipate every possible move the enemy will make, but there does lie a capability to thwart those moves as the SJFHQ becomes aware, or to some extent, anticipates them.

4. Decision Making in the SJFHQ

The essence of planning is to arrive at a decision that can be implemented to accomplish the objective of the plan. During a crisis, time is compressed to the advantage of the initiator of an action. As previously mentioned, the goal of the SJFHQ is to build a net assessment capability that is capable of establishing patterns of hostile actions that can be known and addressed. As those patterns are developed, the elements of the SJFHQ can propose actions based on the context that their commander has them operating under. Arriving at a decision could be a daunting prospect for the heterarchical organization structure, and it would be limited compared to the traditional hierarchy if it did not

produce a decision resulting in greater speed of command and synchronization. Effects Based Operations are time sensitive, and the goal of the SJFHQ is to minimize delay to produce a robust decision for the commander. How then to do that?

a. Command and Control Collectives

SSG XIX proposed a "Command and Control Collective" as a fundamental element of command and control of a network-centric organization (SSG XIX, 2000). These cells are collaborative individuals united over the network, acting on knowledge available to them, directing resources to continually update this knowledge, and proposing courses of action based on the knowledge. The key to utilizing this construct is to aggregate smaller decisions to provide an overall result; essentially effects based operations in reverse. Similarly, complexity theory discusses movement around a fitness landscape as the optimal objective of a complex adaptive system. It is here that smaller decisions manifest themselves to provide an overall fitness for the organization. The elements of the organization (or the cells in a SJFHQ) are motivated to improve their fitness in their own competitive landscapes, with the overall fitness increased as a result. Cells competing for resources are continually adjusting as required based on those allocated resources. They are also able to war-game other possibilities with other resources, and these war games can be used to request additional resources from the commander. In this way the commander has direct access to the linkages, and can observe the effects his movement of resources has on all elements of his organization.

b. "Chunking"

Dr Merry's research in complex adaptive systems has determined that each cell reaches the decision point through a process he calls "Chunking"(Merry, 1999). He believes that large and complex decisions are different than simple decisions in that the complex decision is actually made of many simple decisions (Merry, 1999). A group arrives at a complex decision when it does not attempt to solve the complex decision through the achievement of one goal; rather it should solve a number of goals connected to one issue. Complex decisions also require a search of possible solutions outside of the

cell one is operating in. This premise supports the construct of the SJFHQ as the optimal structure for a Commander as it readily provides this capability. The idea is to arrive at a decision much like the process outline in Dr. Kauffman's NK model (Kaufmann, 1995). As each button was connected to another via a string, there reached a point when the individual buttons were connected to reach a transition point where one more string added much greater fidelity to the overall unit.

E. DECISION MAKING MODEL

Dr. Merry outlines a model by Ralph Stacey in Figure 4.1 that may be used by the commander to illustrate the quality of the decision that has been aggregated from the cell collaboration. [22] It represents the fact that the one thing the commander has control over, the interactions, is what will provide a level of competency in the decision. The model has two axes, a horizontal certainty axis, the other a vertical agreement axis. The certainty axis depicts the degree of certainty in regard to the issue, with the left side of the axis indicating close to certainty, and the right side representing uncertainty. The agreement axis is similar; lower end of the axis representing close to agreement and the higher end indicating far from agreement.

1. Model Zones

On this matrix, Stacey identified 5 zones where the decision of the collaborative cells could lie. These zones are as follows:

1. Close to Agreement, close to certainty
2. Far from Agreement, close to certainty
3. Close to agreement, Far from certainty
4. Anarchy: Far from agreement, Far from certainty
5. The edge of chaos

[22] Merry uses Stacey's model to "select the appropriate management actions with regard to a decision based on the degree of certainty and the level of agreement on the issue in a organization that needs to make the decision (Merry, 1999)

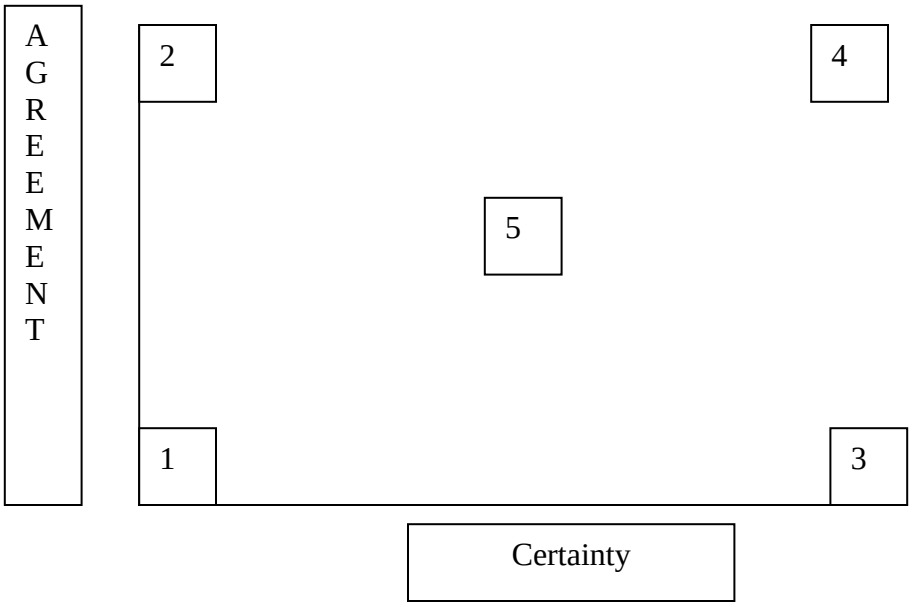

Figure 4.1. The Stacey Decision Making Model.

1. Close to Agreement, close to certainty – An area where future events are predicated on a study of the past. Actions are compared to a given plan to determine their relation to the expected outcome.
2. Far from Agreement, close to certainty – neither plans nor shared mission work in this environment. Requires negotiation, politics or compromise.
3. Close to agreement, Far from certainty – strong sense of shared vision may work, but acting from a set plan will not. Decision is weighed not against a pre-determined outcome, but rather the ability to which it addresses the shared mission
4. Anarchy: Far from agreement, Far from certainty – avoidance is the only way to deal with this situation. Not a good place for organizations to be in.
5. The edge of chaos – High creativity, innovation and collaboration exceed traditional management techniques for resolution.

2. Model Relationships

Traditional hierarchical organizations do very well in making decisions in the close to agreement, close to certainty blocks, and in fact the entire planning process of

JOPES is designed to drive the military planning cycle to that region. While the deliberate planning cycle adds value in teaching the ability to plan, no commander would rely completely on a pre-written plan to conduct his actions. Rather, it is a starting point for his staff to increase their initial position when a crisis resembling the plan emerges.

The SJFHQ is designed to produce decisions when the cells are operating in any one of the regions. The commander's actions may then rely on one of the three types of actions that were discussed in Chapter Three to drive the process to reach a decision. In particular, directive action may drive the organization out of anarchy. Similarly, no action on the part of the commander may allow emergent action to develop, at which some point later directive action may be applied. Either case works to shift the cells from the remaining in an undesirable region for any period of time Encouraging the cells to operate in the middle of the graph, at the edge of Chaos, allows them to be flexible and aware of the developing situation. Varying action types allows the organization to move around a landscape of possible decisions and courses of action, leading to adaptive organizational capacity as demonstrated in a CAS.

3. CAS Relationships

What then is the relationship of the Complex Adaptive System? It is a type of organization that allows for emergent action. This type of action has been shown to produce self-organization that can then be further developed along different Course's of Action. A commander's directive action may act as a catalyst to a CAS, and may lead it to achieve a phase transition earlier than if it had been left alone. As the connections increase, the network achieves greater cohesion and redundancy. For the warfighter, these nodes then serve to provide indications and warnings, and allows the force to re-configure to sense and respond to any perturbation. The key to the CAS is that it provides these indications and warnings at the earliest possible time to the commander and staff. As relationships are shown to exist between sensed data points, the commander can rapidly develop situational awareness, and then begin to apply his dynamically configured organization to fully explore the information.

F. SUMMARY

The FORCEnet proposed by SSG XIX offers tremendous potential for increasing battlespace awareness with the large number of air, surface and sub-surface sensors and weapons that it will have available. These sensors will be forward-deployed to the tips of world events, providing local fidelity to a global information technostructure. Despite all these sensors, however, no organization can sense, interpret, decide, and act on more than a fraction of the signals that pour in from the environment. Where organizations choose to place their sensory probes and how they distinguish meaningful signals from random noise or deception determines whether they will be sufficiently aware of the situation developing. Once aware, they must respond…rapidly; whether in the form of additional sensors, or additional interpretation.

While some envision that the network (FORCEnet) will be capable of making actionable decisions by itself, the purpose of this thesis does not intend to eliminate the relevance of the human decision-maker. Rather the commander and his staff are essential to control of the network and are responsible for the corresponding results of combat action. Their employment of a heterarchical network-centric organization such as the Standing Joint Force Headquarters will enable them to maintain that relationship between military authority and responsibility. This structure will allow them to provide a catalyst for focusing the decision making process when it stalls, provide for network wide adaptive actions, and rely on the emergent properties of the network to provide the initial interpretation of signals and self-organization of the force. It is the human creative thinking capability operating across the organization that is extremely difficult to replicate and will therefore continue to mark the difference between successful COA's and non-successful ones. The dynamic organizational schema will be the conduit for this process to ensure that the network operates at the "Edge of Chaos."

V. DYNAMIC ORGANIZATIONAL MODELING

A. INTRODUCTION

This thesis has proposed that a commander chooses an organizational structure for the fighting force and operational staffs based on the environmental interdependence and envisioned mission tasking. The choice is constrained by the infrastructure preconditions that the force has trained to and has been resourced for. An earlier assumption in this thesis proposed that the structure had a network-centric technostructure, and that the force was trained in the application of network-centric warfighting. These assumptions are for an ideal force, but are required to examine the potential organizational dimensions of how such a force could move among organizational structures.

This thesis has thus considered the future environment that operational forces will face, and identified some characteristics of organizational structure as they apply to a variety of directive, adaptive, and emergent tasks. Two options for an organization were discussed, the JTF and the SJFHQ, as they related to the planning function leading to a decision, or Course of Action. This chapter will provide supporting analysis for the proposed dynamic organizational schema articulated in the thesis in the form of an analytical model for structural modulation.

B. SOURCE OF MODEL

1. A Dynamic Theory of Organizational Choice

The organizational structure propositions in this thesis have been discussed as to their dependence on contingency, or environmental, factors as the primary influencing factor for the resulting structure. These factors have been noted as to their effects on structure, as well as the requirement that they drive to modulate between structures to best fit the given conditions. It has also been proposed that in doing so, modulation may provide the commander an increase in combat power, as the organization adapts to best fit the new environmental conditions.

Jack Nickerson and Todd Zenger examined this proposition, and have developed a model for structural modulation that argues that "efficiency may dictate modulating between discrete governance modes in response to a stable set of exchange conditions". (Nickerson and Zenger, 2002). In the model, they examine whether the effectiveness is achieved by transitioning to a new discrete structure, or whether the transition itself provides the best efficiency gains. This model is outlined below as they describe it.

2. Examination of Previous Research

Their model is appropriate for analyzing the Dynamic Organizational Schema as it considers that management may desire to change the structure for a number of reasons. Environmental conditions contribute, but do not thoroughly define the reasons for structural modulation. In other words the model considers not only environmental responses, but other factors such as the commander's intent and leadership as prevalent to achieving increased combat effectiveness.

Research conducted by Nickerson and Zenger noted several cases of organizations that showed a "pattern of vacillation" among organizational structures leading to an increase in organizational effectiveness.[23] Hewlett Packard for example switched between a centralized and decentralized structure five times from 1985-2000, each time demonstrating an increase in stock price as a result. While they point out that the change in structure does not empirically correspond to a change in stock price, these changes were necessary to achieve the objectives of the company's leadership. Similarly, they identify the accounting firm of KPMG as having experimented with three different organizational structures over a seven-year period, ranging from industry-focused to functional to geographic (Nickerson and Zenger, 2002).

3. The Thermostatic Feedback Model

Nickerson and Zenger's model is a "Feedback Model of Mode Choice" based on system dynamics (Forrester, 1961), and feedback theory (e.g. Dorf 1980). They use this

[23] It is noted that switching in this case is not indecisive, but rather depends on active command decision making to achieve fitness. Therefore, vacillation will be referred to throughout the rest of this thesis as oscillation.

model to demonstrate modulation based on a switching interval, as one might observe in a thermostatic control system. Such a system controls a set point using two extremes; in this example a heater and a cooler are used to control a specified temperature in a room. This is a two dimensional model, which suits their proposed theory that organizations may switch between structures for two dimensional models, or among structures for greater than a two dimensional model. The model is designed to observe two effects. The first one is the extent to which structural changes between two modes can cause the organization to maintain the capabilities of both modes around a specified functionality. The second effect is to observe the costs of switching back and forth between modes as a function of the cost benefit analysis that is associated with mode switching (Nickerson and Zenger, 2002).

4. Relation of a Thermostatic Model to the Dynamic Organizational Schema

a. Hierarchical vs. Non-hierarchical

This model was used in a bi-dimensional aspect to observe these effects as they apply to the Dynamic Organizational Schema. A two dimensional model is used to observe the effects as they may occur over a time averaged period, but does not require the additional analysis that a multi-dimensional model would. It is assumed here that the relationship of the model to the Schema will not change as it is applied to the three organizations discussed in this thesis (JTF, SJFHQ, and the CAS).

The two dimensions that will be examined are the hierarchical and non-hierarchical structures discussed earlier, as they define the extremes of the organizational structures discussed. The expectation is that these extremes will be used to vacillate around the set point, and the inference is that the heterarchy will incorporate the qualities of both the hierarchy and the non-hierarchical structures to produce an adaptive organization.

b. Configuration as a Control Variable

The Nickerson and Zenger model is developed on the premise that the choice of an organization's structure may influence but does not define the actual functionality. Rather they point out that the formal organizational structure appears to strongly influence an associated informal organization. The informal organization consists of the social aspects of the organization, often incorporating the culture that exists within the bounds of the formal structure. The informal structure can have effects on the formal structure as it represents the manner in which information actually flows as opposed to the "blueprint for organizational behavior (Scott, 1981). It is the informal organization that is actually modeled, as it is the primary determinant of an organization's functionality. Formal structure is a mechanism through which the informal organization can be shaped, and the model must recognize the contributions of each of these (formats) (Nickerson and Zenger, 2002).

C. MODEL ASSUMPTIONS

To frame the model, Nickerson and Zenger outline three assumptions. These are necessary as they relate the model to the structural patterns of oscillation that are discussed.

1. Discreteness

The first assumption states that "the choice of organization for any given activity is discrete" (Nickerson and Zenger, 2002). This assumption reflects that organizational change is not continuous, and that management will choose organizational forms that may best fit the environment, but do not perfectly fit it. This assumption is required so as to stipulate that the model will observe an organizational structure choice as a specific decision to move from one structure to another.

Discreteness in organizational form is relatively widely accepted among organizational theorists. Nickerson and Zenger point to punctuated equilibrium models where Gersick (1991) argues that "systems do not evolve through a gradual blending from one state to the next". Nickerson and Zenger (2002) further support this discreteness

in organizational forms by observing that attempts to marginally change form will be resisted by deep structure.

2. Inertia

The second assumption states that "the actual functionality of an organization embedded in the informal organization responds with inertia to changes in the organization's formal structure" (Nickerson and Zenger, 2002). This assumption recognizes that with any shift in organizational structure there will be an inertia present that will either assist or resist the change to the next structure. Such inertia could come from the informal organization that does not want to change due to a requirement for realignment, more training or similar issues. Nickerson and Zenger (2002) observe that the "existence of inertia in the formal organization causes an organization's functionality to change more slowly than change in the formal organization. There is a lag between the implementation of a new formal structure and the realization of the new structure's steady-state functionality".

The author proposes that overcoming or utilizing inertia as an element of the Dynamic Organizational Schema will require a commander to emphasize the intent and scope of the operation, providing access to this information across the network. Such inertia could be useful to the commander. An organization that positively applies inertia could realize gains in speed of command as the force anticipates and positions to work coherently with the overall strategy. An organization that resists change may be overcome by another organization that does not resist, leading to a competitive advantage of the latter over the former.

3. Costs of Change

The third assumption states "organizational change is costly. Such costs include up-front costs and dynamic costs of change in which the latter diminish as interpersonal conflicts and role uncertainties under the new organizational mode diminish" (Nickerson and Zenger, 2002). This assumption is necessary to account for the loss of effectiveness that may occur with change in an organizational structure. Up-front costs for the

Dynamic Organizational Schema might include or the cost of equipping and maintaining the required network-centric technostructure. Dynamic costs are transitional, and may be reflected as a true cost that requires extra training for forces or a transition delay to move forces, or as opportunity costs which occur in the form of lost time on an objective as the force reconfigures around a new organizational structure. There are other examples of this cost of change as it applies to this thesis. The disruption of the trust that forces and the commander have developed over time over the network would impact the collaboration over a network (Wiesenfeld, Raghuram, and Garud, 1999). Additional time for newly connected elements to build relationships may also be a factor in judging the costs of transitioning from non-hierarchical to hierarchical structures. The informal structure may bear the majority of such costs as organizational structure changes, and therefore may present the greatest inertia against change (Nickerson and Zenger, 2002).

D. EFFICIENCY ENHANCING MODULATION

1. Concept of Oscillation

a. Model Assumption Effects

Nickerson and Zenger highlight two areas of interest as they apply to the concepts discussed in this thesis. The first one is related to Assumption 1, that organizational structures are discrete. If this is true, then it would also appear to be true that a given organizational structure might not always be synchronized to a change in environmental conditions that it was originally structured for. As the conditions change, the structure would most likely remain where it was assuming that no actions were taken to change it, possibly due to reasons of inertia or costs of the change. Such was the case in the Hewlett Packard example, as it was not until the company's leadership formally changed the organization that a gain in efficiency was noted.

This example leads to Assumption 2, that the organization displays the functionality of both structures as it attempts to reach the set point between the two (Nickerson and Zenger, 2002). Nickerson and Zenger raise the question as to whether a dynamic efficiency gain can be had as the switch is made from one discrete structure to

the other. Assuming that the set point is the ideal area for an organization to be functioning at any particular point in time, it would appear that the organization would gain in efficiency as it better approximates the desired functionality state with the actual functionality state. The model replicates this as a single variable for simplicity sake, but in reality there are any number of factors that feed into determining the ideal functionality. For the Dynamic Organizational Schema, the set point may be assumed to be an ideal point as defined by the commander, and therefore one of the functions of command is to determine how tightly or loosely coupled the organization should be.

b. Oscillation Effects

The organization will most likely never be tuned exactly to that set point, whether it is due to inertia that fights the change, or the very cost of the change itself. Also, by definition, the Schema is dynamic, so it is unlikely that the set point will ever actually be set for any long period of time. As a result, the actual organizational functionality will vacillate around the set point, with the organization revealing tendencies of each dimension of structure. In other words, the commander may be able to adjust the set point such that hierarchical and non-hierarchical elements will be working in concert, across the network, allowing the organization to function as a heterarchy. As the inertia of an organization moves to adjust to new conditions, it seems that the organizational characteristics of high inertia for innovation and low inertia for status quo may respond best to requirements for change.

c. Functionality Model

Nickerson and Zenger (2002) developed the model to examine the factors that influence when modulation is efficiency enhancing. To do this they developed a functionality proposition and a supporting performance index that allows the user to vary inertia and costs. They represent the organization's functionality by "a single, time varying variable $y(t)$." The single variable allows the user to analyze the modulation between two modes, where Mode 1 = d_1 & Mode 2 = d_2. The modes are then normalized so that $d_1 = 1$ and $d_2 = -1$, and the desired set point is then assumed to equal zero

represented by $u = 0$. These assumptions assume that the desired set point lies precisely in between the steady-state functionality delivered by the two modes. Changing the set point can then alter the desired functionality.

They model the difference between the actual and the desired set point as an "error" which they describe by

$$(t) = u - y(t)$$

They then propose that management switches to Mode 1 from Mode 2 when $\varepsilon(t) \geq \varepsilon_h$, and from Mode 2 to Mode 1 when $\varepsilon(t) \leq \varepsilon_l$ where ε_h represents an upper threshold, and ε_l represents a lower threshold. They apply a standard response function with an exponential decay to yield a function that represents the level of inertia in a single parameter, represents the organization's actual functionality as provided by the informal organization, and responds to a change in organizational mode according to

$$y(t) = d_j - (d_j - y_0)\, e^{-\gamma t}$$

where t is the switching interval, y_0 is the output value, or level of functionality when the switch is made, and dj ($j = 1$ or 2) is the new chosen organizational structure. The term γ is referred to as a time constant and is an indicator of how quickly the output responds to a change in input.[24](Nickerson and Zenger, 2002).

d. Model Results

Nickerson and Zenger state that "The model works like the thermostatic system that it replicates. At time $t = 0$, management switches to Mode 1; $d(t)$ immediately transitions from d_2 to d_1. The organization begins to move toward the set point and toward Mode 1 at an exponential decay. As the $\varepsilon(t)$ passes the set point and moves

[24] Nickerson and Zenger state that "In feedback theory, the term γ is referred to as a time constant and is an indicator of how quickly the output responds to a change in input. The inverse of γ can be interpreted as the organization's resistance to change. Thus organizations with high degrees of inertia correspond to low values of γ and respond more slowly that organizations with low degrees of inertia" (Nickerson and Zenger, 2002).

toward the Mode 1 functionality, the error increases, and eventually triggers the system to reset to Mode 2, starting the process over again" (Nickerson and Zenger, 2002).

2. Effects of Costs of Change on the Dynamic Organizational Schema

The mode switching application of the model did not consider the costs of change as a direct function of the need for change. Nickerson and Zenger do address the costs of change in their model, however, using a quadratic to account for both the up-front and the dynamic costs. The dynamic efficiency gains of modulation must also consider the costs of change in order to determine if there was a net gain in efficiency. The model provides a performance index that accounts for both the costs and efficiencies, thereby determining the overall performance change of the organization modulation. In addition to running a baseline model, sensitivity analysis was conducted to determine the impact of the costs vs. benefits in organizational modulation.

a. Performance Index

Nickerson and Zenger (2002) define a "quadratic performance index, *J*, which is comprised of the dynamic efficiency gain of modulation, the up front costs of change, and the dynamic costs of change. The performance gain is defined as the performance benefit that accrues or dissipates as an organization's functionality better or worse approximates the optimal functionality." The performance index integrates costs and benefits over the interval *S.* [25] It is represented by

$$J = {}_0\int^{S} - w_1\varepsilon(t)^2 - w_2(d_j - y(t))^2 - SF/T\, dt$$

They also define "*F* as the up-front cost, and the dynamic cost is modeled by squaring the difference between steady-state performance d_j, and actual performance y(*t*). Thus as *y*(*t*) approaches d_j, the dynamic cost of change diminishes. The parameters

[25] Nickerson and Zenger state that "A common approach for optimizing a performance index based on a system with a nonlinear decision rule is by simulating the system's operation for different values of the control parameter over a finite interval *S*. *S* is chosen so as to be sufficiently small so that the integral is finite, but large enough that any transient dynamics due to the initial condition at t = 0 dissipates" (Nickerson and Zenger, 2002).

w_1, w_2, and F determine relative benefits (w_1) and costs (w_2 and F) of mode switching." T corresponds to an optimal time between mode switching, and represents an optimal point that the management has for modulation (Nickerson and Zenger, 2002).

b. Model Results

The baseline model was run to determine the effects of inertia on the model. The switching interval was varied to indicate the relation of inertia on the performance index. Nickerson and Zenger found that small switching intervals resulted in poor performance, and they attribute that to the fact that the organization is constantly changing and the inertia does not exist for better or worse. As the interval increases, the performance level also increases, but eventually reaches a point where the interval is so long that J decreases. Through their analysis, they drew several conclusions: (Nickerson and Zenger, 2002)

- The optimal switching interval increases with inertia
- Higher levels of inertia (to a point) produce higher levels of performance
- Switching faster than is optimal penalizes performance more than delaying switching does. Also, higher levels of inertia result in a faster rate of decay in the performance.

c. Sensitivity Analysis

Finally, they ran a sensitivity analysis on the relationship that the costs of change had to the performance index, and the results were determined (Nickerson and Zenger, 2002). They noted that:

- Increases in the up-front costs yielded lower values of the performance index.
- Decreasing the benefit of proper modulation decreased the performance index
- Increase of the dynamic cost did not affect the switching interval but did decrease the performance index.

3. Triggers for Modulation

While there are many operational reasons for considering modulation of an organizational structure to another type, this model and subsequent analysis shows that

there are additional costs associated with modulation. These costs are both up-front and dynamic, and when these costs are high, modulation may not be the best course of action. Additionally, it appears as if both very small and very large switching modulations do not greatly improve performance in modulating organization, and that the organization is better to be late in modulating than early. This last statement may also be reinforced by the associated risks of the unknown that an organization may face if it is the first to modulate. Finally, this analysis does not necessarily consider a deceptive environment where an organization modulates based on a perceived, but untrue, environmental condition.

E. IMPLICATIONS FOR THE DYNAMIC ORGANIZATIONAL SCHEMA

The model used in this analysis can not completely analyze the Dynamic Organizational Schema to the extent that it has been proposed as a working organizational architecture for the network-centric organization. Rather, the Nickerson and Zenger model, by their own admission, is "limited to an organization's desired functionality that lies between two discrete organizational modes." Nevertheless, some inferences may be drawn from their conclusions as they relate to the network-centric organizational constructs proposed in this thesis.

1. Relationship of Switching Interval to Inertia

The optimal switching interval increases with inertia (Nickerson and Zenger, 2002). The greater the inertia, the greater the recommended switching interval. If inertia, as it applies to the three organizational configurations outline in this thesis, is set to the level of formalization, then the most hierarchical organization would display the greatest inertia. As such, it seems as if the more hierarchical the organization, the greater the switching interval is recommended. A commander might read this to assume that it will be difficult to overcome the inertia of the hierarchy, and therefore should assume that it will take longer to shift from the hierarchical structure to an alternate structure. The least formal structure, the CAS, would have smaller inertia as defined here, and therefore could be switched more frequently to get a corresponding result.

2. Relationship of Inertia to Performance

Higher levels of inertia produce higher levels of performance (Nickerson and Zenger, 2002). Formalization does have its benefits, as outlined earlier. A hierarchy for example, was shown to be very adept at implementing planned actions, as it provided directive authority to accomplish an action. The CAS on the other hand, was more flexible, inclined to self-organization, and required a catalyst to speed up the desired functionality. Given the increase in formalization over the CAS and holding the switching interval constant, it would appear that this conclusion would support higher levels of performance due to inertia of the Hierarchy over the CAS. The heterarchy could be expected to fall in between the two results, as it is more formalized than the CAS, but less so than the Hierarchy.

3. Relationship of Switching Rate to Performance

Switching faster than is optimal penalizes performance more than delaying switching does. Also, higher levels of inertia result in a faster rate of decay in the performance (Nickerson and Zenger, 2002). There is an optimal point for the switching interval and if that point is exceeded, the organization will pay a performance penalty greater than if the switch was made prior to the optimal point. Accepting the previously defined relationship where inertia equates to formalization, it would also appear that the hierarchy would pay a greater penalty if that switch is made too early, whereas the heterarchy and then the CAS would pay even less of a performance penalty for an early switch.

4. Relationship of Up-Front Costs to Performance

Increases in the up-front costs yielded lower values of the performance index (Nickerson and Zenger, 2002). Higher up-front costs appear to decrease the performance index across the board. The question then is what are the up-front costs for moving from a hierarchy or CAS to a heterarchy? While not fully explored in this thesis, earlier it was observed that a physical asset business (platform centric) for example, may have a 30% up-front/70% dynamic cost structure with a corresponding twofold rise in margins as

output doubles. A network structure, on the other hand, may have a 90% up-front/10% dynamic cost structure, with a corresponding fourfold rise in margins as output doubles. It would appear that the greater the network infrastructure, the greater the up-front cost. This does not really apply in this thesis however, as the Dynamic Organizational Schema assumed that the network-centric technostructure existed for all three proposed organizational structures. Therefore the up-front costs equally applied to all three structures. More research is required in this area to determine the up-front and dynamic costs of each structure.

5. Relationship of Modulation Benefits to Performance

Decreasing the benefit of proper modulation decreased the performance index (Nickerson and Zenger, 2002). Again, this conclusion would appear to apply unilaterally across all three organizational structures. Costs held constant, if the benefits to be gained by modulation are small, then it may be best not to modulate. Said another way, an organization should not modulate just because it can. There must be a distinct benefit to be attained, and if that benefit is sufficiently small, it may not exceed the costs, even if they are held constant. In that case, modulation may result in a decreased performance index.

6. Relationship of Modulation Benefits to Performance

Increase of the dynamic cost did not affect the switching interval but did decrease the performance index (Nickerson and Zenger, 2002). Dynamic costs also impact the performance index, with higher costs leading to a lower performance index. If the costs are high enough, all efficiency gains from modulation may be eliminated. These costs did not impact the optimal switching point.

F. SUMMARY

The Nickerson and Zenger model was used to analyze the effects that modulation of discrete organizational structures has on the overall performance of the organization. This performance was related to the efficiency at which an organization's actual functionality related to the desired functionality and a number of observations were made

using the model's output. These outputs were then developed as factors that influenced a commander's decision to modulate the organization amongst a hierarchy, heterarchy, and a complex adaptive system. These organizational structures were developed throughout the thesis as the Joint Task Force, the Standing Joint Force Headquarters, and the Complex Adaptive System. While the model did not address every aspect of the modulation, it did outline a case for dynamic efficiency gains to be had due to modulation.

This model has demonstrated a management task to optimally modulate discrete choices in a manner that dynamically positions the organization in some optimal location in a multi-dimensional performance state. Structural changes in organizational form can keep an organization's actual functionality vacillating around a desired functionality, and it may therefore be possible for a Commander to tune his organization between hierarchical and CAS attributes to attain heterarchical functionality. A Commander's task then is to set the desired functionality, and employ a command and control system that can permit reconfiguration around that set point. The set point will be determined by the Commander's desire for a specific functionality, which has been otherwise defined in this thesis as an action type.

VI. CONCLUSIONS AND RECOMMENDATIONS

Hyper-competitive environments represent an area of dynamic change. These conditions highlight an emerging era of network warfare, where conventional force structure may be inappropriate for all conflict resolution. While a commander may set a desired functionality for the organization, it does not necessarily anticipate the full range of functionality that is required due to factors such as uncertainty and equivocality. A military organization that organizes as a network-centric organization may not have to limit itself to such a single structure, and dynamic efficiency gains may result from modulation among a number of different structures.

SSG XIX proposed that the future construct for naval operations would be under the umbrella of the "FORCEnet". The propositions for the FORCEnet include a global network that local units could add sensory fidelity to in the form of large numbers of manned and unmanned vehicles and platforms. These units would work in concert with front line warfighters and rear echelon command and control collectives to rapidly leverage intelligence, command requirements and weapons to attain competitive advantage. The FORCEnet would give rise to a network-centric organization, and that organization could leverage varying organizational structures to achieve the commander's intent. The ability to dynamically shift among organization structure of forces would serve as an enabler to network-centric warfare.

A. CONCLUSIONS

The concept of a Dynamic Organizational Schema for a network-centric organization was explored as a relationship of functionality to environmental conditions. The conditions of network warfare were discussed as the emerging environmental conditions of warfare and the resultant force was postulated to organize under three distinct organizational structures so as to attain a specific fitness to the ecological conditions.

Specifically the following points were noted:

- A network-centric organization is required for network-centric warfare, and the organization must be capable of dispersing and distributing combat power

utilizing a dynamic organizational structure that can rapidly sense, decide and act.

- Recent research into social network theory has identified agent-based models that may address the control requirements of network command and control and to a lesser extent the command requirements in the form of self-organization and emergent behavior.
- The command element can be represented as a functionality requirement. This was represented as three levels of tasks that a commander of a network-centric organization would need to accomplish to attain competitive advantage. Directive, adaptive, and emergent actions were examined as potential functions and a relationship was established to their relevance to warfare tasks such as crisis action planning.
- Modulation of organizational structures may offer dynamic efficiency gains as the organization vacillates around a desired set point.

The modeling of the Dynamic Organizational Schema using the Nickerson and Zenger model demonstrated the need for further exploration of this concept. Although limited in fidelity, it did provide a method of examining the proposal for a bi-dimensional organizational construct. The concept of oscillation enhanced the earlier proposals that a network-centric organization could attain desired attributes of hierarchical and non-hierarchical systems to replicate heterarchical functionality.

B. RECOMMENDATIONS FOR FUTURE RESEARCH

During the course of this research, a number of areas were touched on that deserve further research. Also, the thesis was limited in that it focused primarily on a joint operational force. Further areas of research should be conducted to explore these dynamic organizational concepts across a larger scope.

Specifically, the following areas require further research:

- Explore the work conducted in this thesis in greater detail. Extend the configuration choice model to FORCEnet qualities of self-organization and self-synchronization. Include a study of the proposed collective Command and

Control cells as they would mathematically relate to factors of inertia and costs of change.

- Model the conditions and triggers that would lead a commander to modulate organizational structure. Define the costs, the inertia and the expected efficiency gains.
- Identify the procurement cycle to achieve the technological capability that is required for the capabilities defined in this thesis. Examine each of the services' programs and visions to ensure they are aligned with a joint operational force requirement.

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